

West Junction US 160/US 550 Durango Intersection Improvements



Presentation began at approximately 4:20 PM. Introduction, purpose and need for project. During initial project discussions, only a CFI was proposed for the west junction of US 160/550,

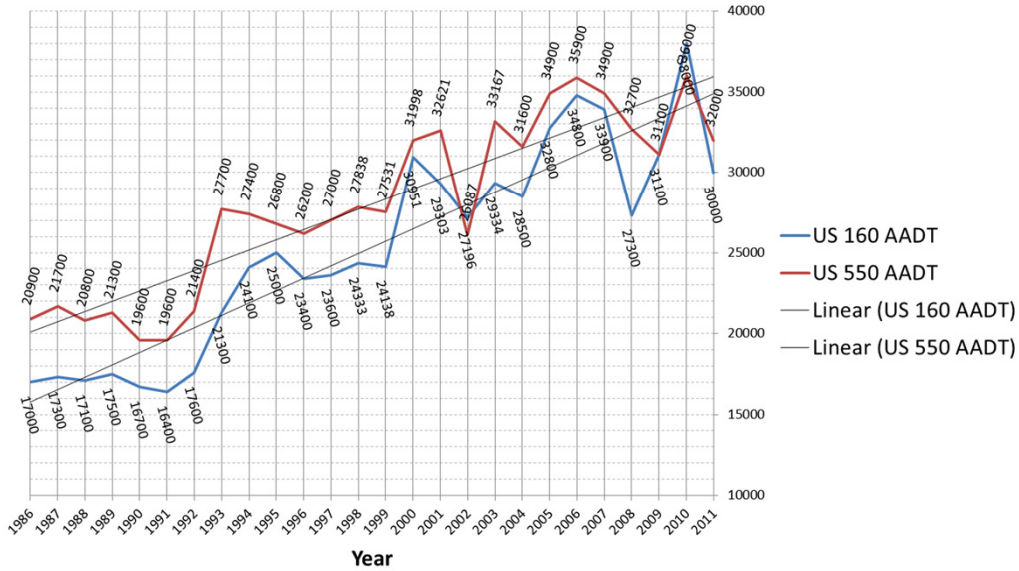
The close proximity to College/Camino del Rio(US 550) expanded the discussion to also include that intersection

Existing CDOT/City of Durango Access Control Plan showing raised medians and a need to further improve the pedestrian crossing of Camino at 7th created the need to also look at these items as part of the overall project.

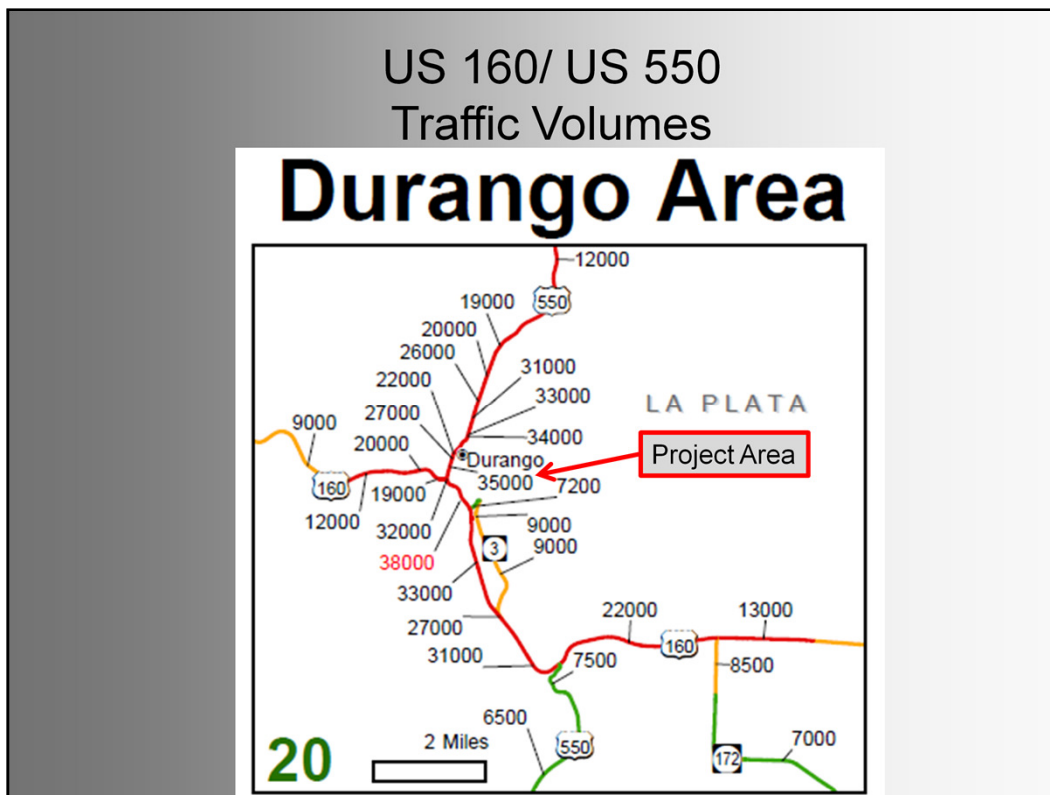


US 160/ US 550 Traffic Growth

Doubletree Intersection US 160/US 550 Historic Average Daily Traffic



West Junction US 160/US 550 Historic Annualized Average Daily Traffic Volumes showing growth trend.



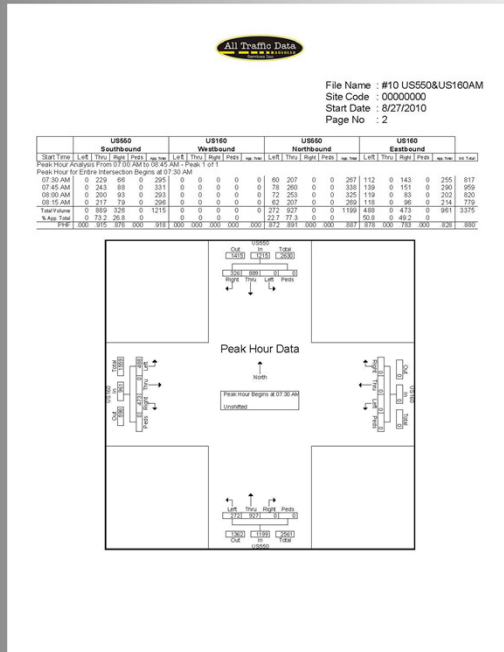
Traffic Volumes of the Durango Area. Red numbers are from a continuous traffic recorder (i.e. A device that runs 24/7 counting traffic.) For being a small town and a small County, Durango and surrounding areas generate significant traffic volume on the State Highways.

It is a common misconception that the State Highways in Durango are to serve only through traffic. The amount of traffic going through Durango is relatively small. Traffic patterns in Durango are everyone is coming to Durango weekdays in the AM, traveling around and about during the middle of the day, and leaving in the PM. The State Highways are attempting to manage the Traffic generated by Durango and its surrounding communities.

Annualized Average Daily Traffic. Average daily traffic throughout the year, summer volumes tend to be higher and winter volumes tend to be lower. Durango's summer peak is more pronounced than areas that have less tourism.

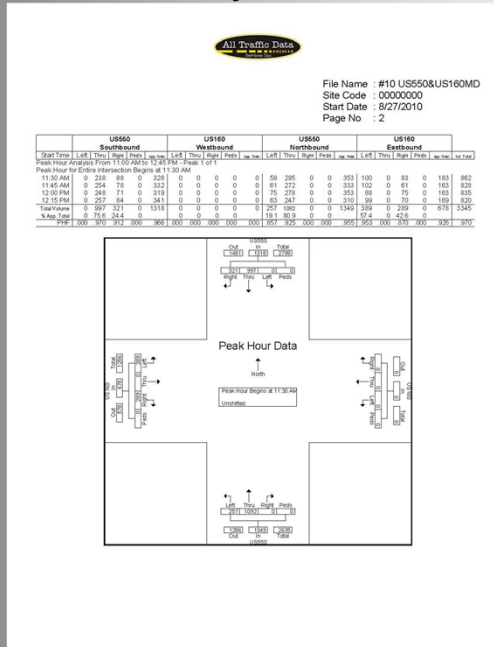
West Junction US 160/ US 550

2010 AM Traffic Counts



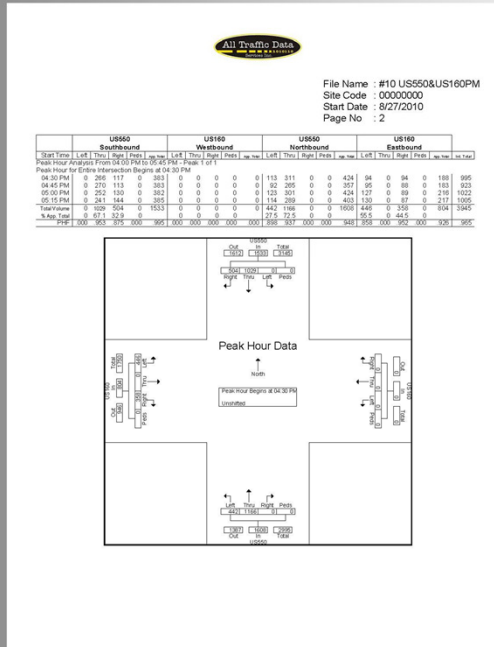
AM summer traffic counts for the west junction of US 160/550

West Junction US 160/ US 550 2010 Mid-Day Traffic Counts



Mid-Day summer traffic counts for the west junction of US 160/550

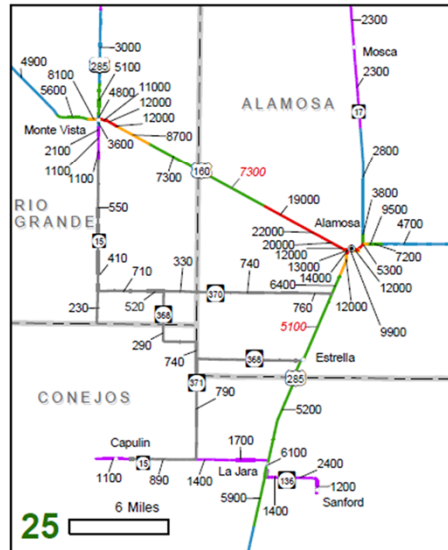
West Junction US 160/ US 550 2010 PM Traffic Counts



PM summer traffic counts for the west junction of US 160/550. PM summer is the busiest time of day, but this intersection is busy all day long. The intersection analysis tool discussed later in the presentation uses these counts, but the results are similar using counts from other times of the day. All of the counts are from summer 2010, the raw counts of course do not reflect future traffic growth.

Traffic Volumes

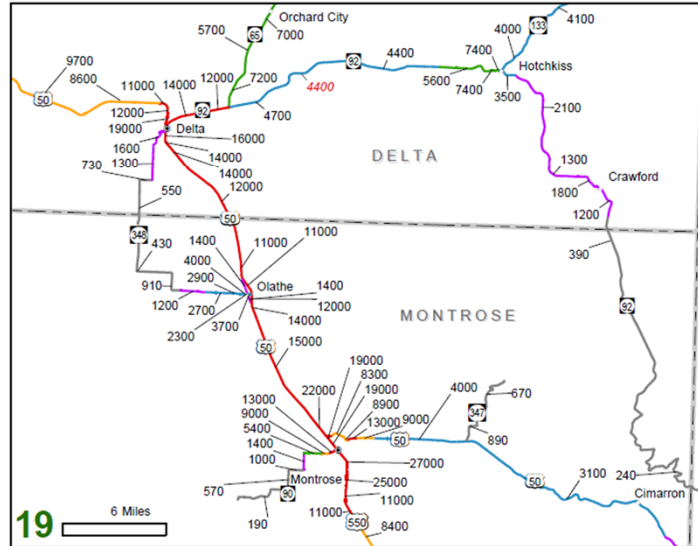
Alamosa Area



Durango State Highways carry more traffic than Alamosa State Highways

Traffic Volumes

Montrose Area



Durango State Highways carry more traffic than Montrose State Highways

Traffic Volumes

Grand Junction Area

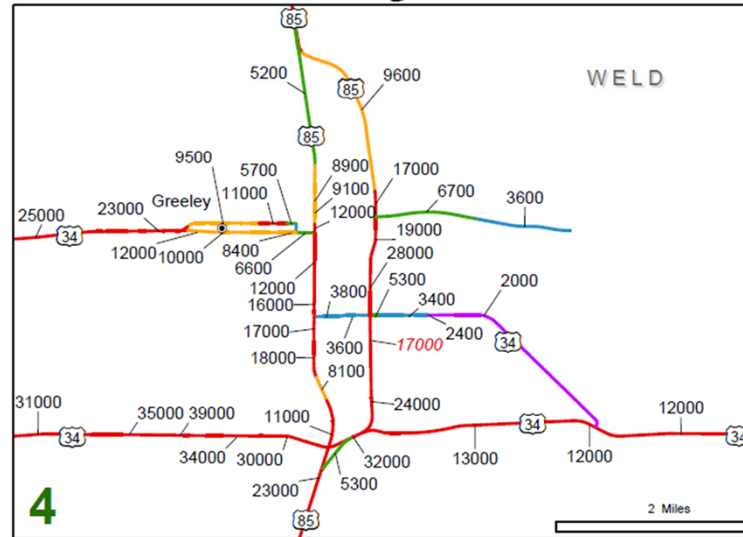
The map displays the Grand Junction Area with various roads and traffic volumes. The roads are color-coded: blue for major highways, red for secondary roads, and green for local roads. The traffic volumes are indicated by numbers along the roads. The map also shows the location of Mesa, Grand Junction, and Clifton. A scale bar indicates 2 miles.

13 2 Miles

go State Highways carry more traffic than Grand Junction State Highways

US 160/ US 550 Traffic Volumes

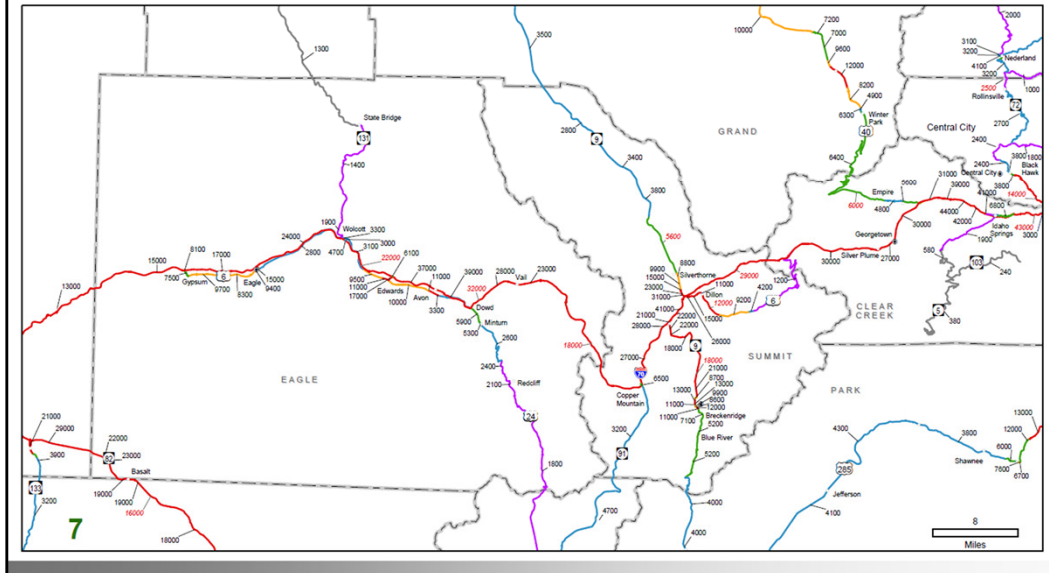
Greeley Area



Greeley State Highway volumes as a comparison to Durango

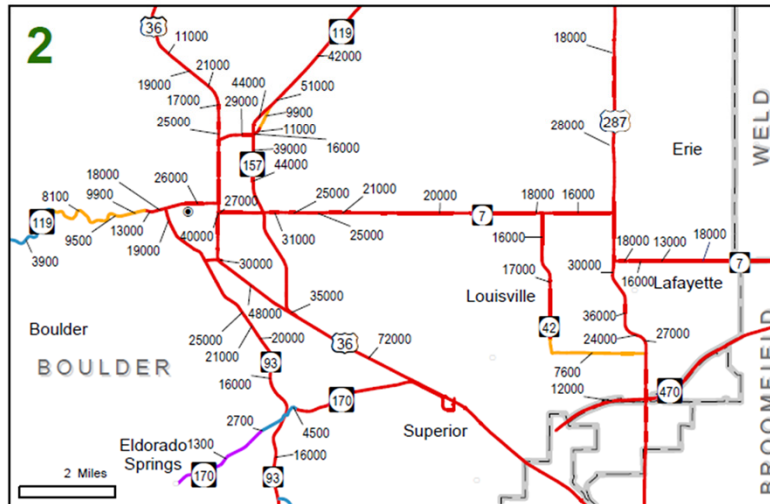
Traffic Volumes

West I-70 Corridor Area



West I-70 volumes as a comparison to Durango

Boulder Area



Boulder volumes as a comparison to Durango

US 160/ US 550 Existing Traffic Congestion



Even during non-peak traffic volume times of year, summer is busier than winter, congestion has grown over the years. This is a typical winter busy time of day photograph showing queuing from the College/Camino intersection through the west junction US 160/550 intersection.

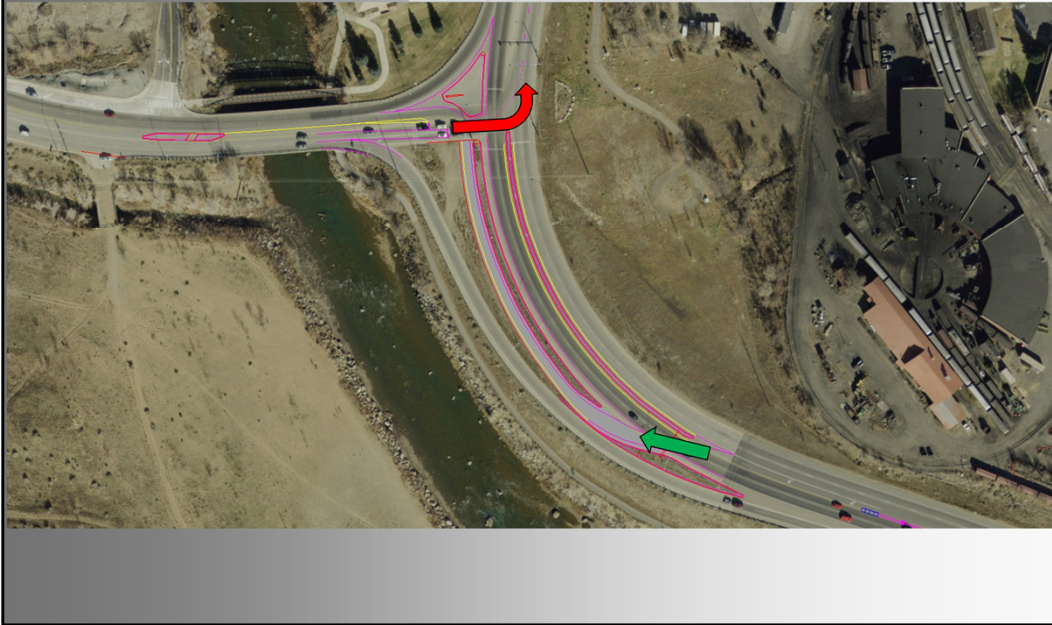


US 160/US 550 (Doubletree) Existing Conditions-

Left Turn from NB US 550(Camino del Rio) to WB US 160 competes for signal time with the left turns from EB US 160 to NB US 550 and the SB US 550 through movements. All three movements conflict with each other and must occur at different times.

US 160/ US 550 Continuous Flow Intersection (CFI)

Step One



West Junction US 160/US 550 Continuous Flow Intersection (CFI) Step 1-
NB US 550 to WB US 160 left turn crosses SB US 550 prior to the intersection with an additional traffic signal.

Since these two movements do not conflict they can in large part occur concurrently.

The NB left crossover movement is signalized with the same indications used at other signalized intersections. The northbound crossover would see green, yellow, and red arrow signal indications, while the southbound movement would see green, yellow and red ball indications.

There are several other locations in Durango which have closer signal spacing than these two signals.

US 160/ US 550 Continuous Flow Intersection (CFI)

Step Two



West Junction US 160/US 550 Continuous Flow Intersection (CFI) Step 2-
NB US 550 to WB US 160 left turn occurs concurrently with the SB US 550 through
movements since these movements also no longer conflict.

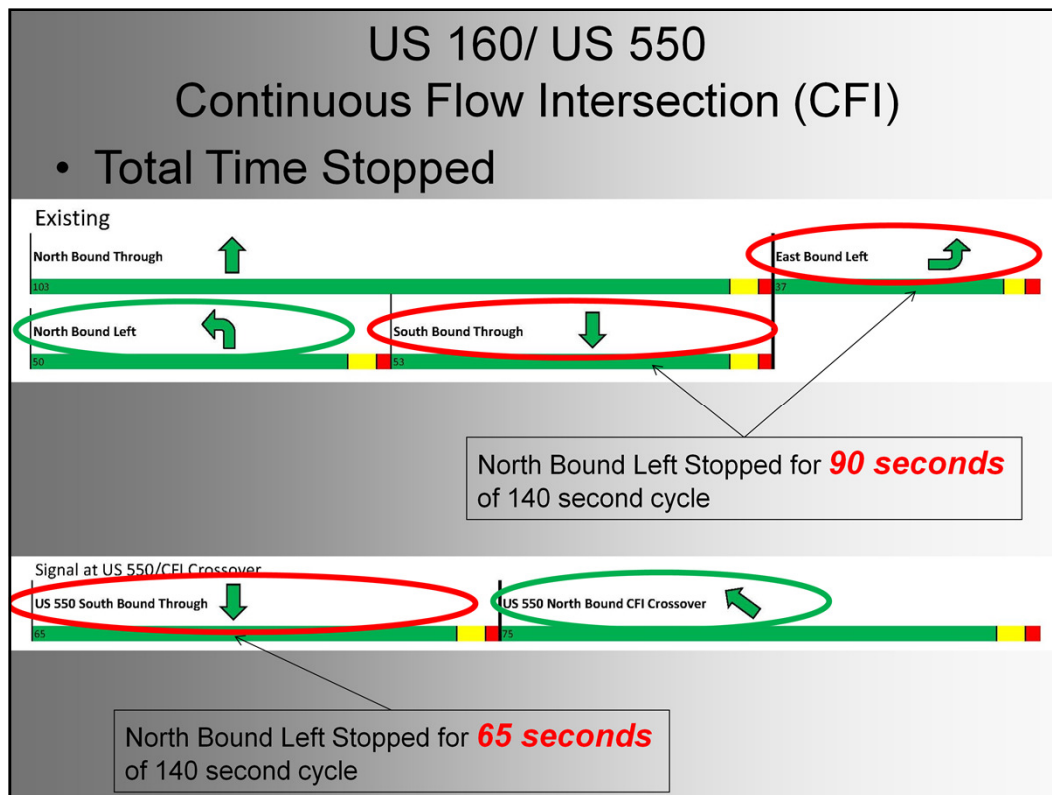
By removing the conflict between movements the movements can occur at the same time
vs. different times, which provides more available time for all movements at the signal for
any given signal cycle.

US 160/550 CFI Traffic Model



See video link on website.

This model uses current summer PM peak traffic volumes (busiest time of day, busiest time of year) and incorporates the CFI and proposed College/Camino del Rio intersection improvements. This is a conceptual representation using real volumes, but it does not accurately reflect the space given for turning large trucks or of the available left turning vehicle storage space prior to the northbound left crossing southbound traffic. Those items will be addressed in the actual design of the project and are discussed later in the presentation.



Example traffic signal split timings.

The green arrows indicates the vehicular movement at the intersection, the green, yellow, and red bars correspond to the amount of time the traffic signal gives those signal indications for the corresponding movement shown by the arrow.

The top chart shows the current summer PM signal times at the existing signal, the bottom chart shows the signal where the northbound left crosses SB US 550 traffic.

With a CFI, since the north bound left at the existing signal can run at the same time as northbound and southbound through traffic, and must only stop for the east bound left, the additional CFI signal where the northbound left crosses southbound US 550 traffic becomes the limiting factor for the northbound left and southbound through movements. Although there is an additional signal with the CFI, since the northbound left crossover can occur at the same time as the eastbound left, *more* time can be given to both the southbound through and the northbound left, and *less* time is spent stopped.

A concern was raised about the possible southbound stop at the additional CFI crossover signal in snow conditions. The steepest portion of the road just south of the existing west junction US 160/550 is at a 4% grade. Starting from a stop on a 4% grade in any conditions should be a non-issue as there are many steeper sections of roadway in this part of the state where people start from a stop in winter conditions without problems.

US 160/ US 550 Continuous Flow Intersection (CFI)

- Left Turn Lane Lengths

Average Queue

- 564 vehicles per hour
- 140 second cycle length
- Effective green 71 seconds
- ~11 vehicles

$$Queue_{avg} = \frac{v}{3600/(C - g)}$$

95th Percentile Queue

- 1.6 * Average Queue for high volume movements
- ~18 vehicles

25' per vehicle = 450', 550' currently installed

Look at extending crossover turn lane on US
160/550

People have expressed a concern over the available space for storing northbound left turning vehicles. This is an example of using the adjusted left turn volumes (i.e. adjusted for some future traffic volume growth over the years, current PM rush hour is 450 vehicles making the northbound left) and using common formulas to check the adequacy of the length for vehicle storage of the left turn pocket prior to the northbound left crossover of southbound traffic. This example shows the calculated storage requirement is nearing the available storage, and a closer look is necessary regarding the adequacy for storing northbound left turning vehicles. Since vehicles only stack when they have a red light, techniques such as coordinating the northbound traffic release from Santa Rita to arrive on the green signal indication for the northbound left crossover of southbound traffic can help minimize the number of vehicles being stored in the northbound left turn lane prior to the crossover.

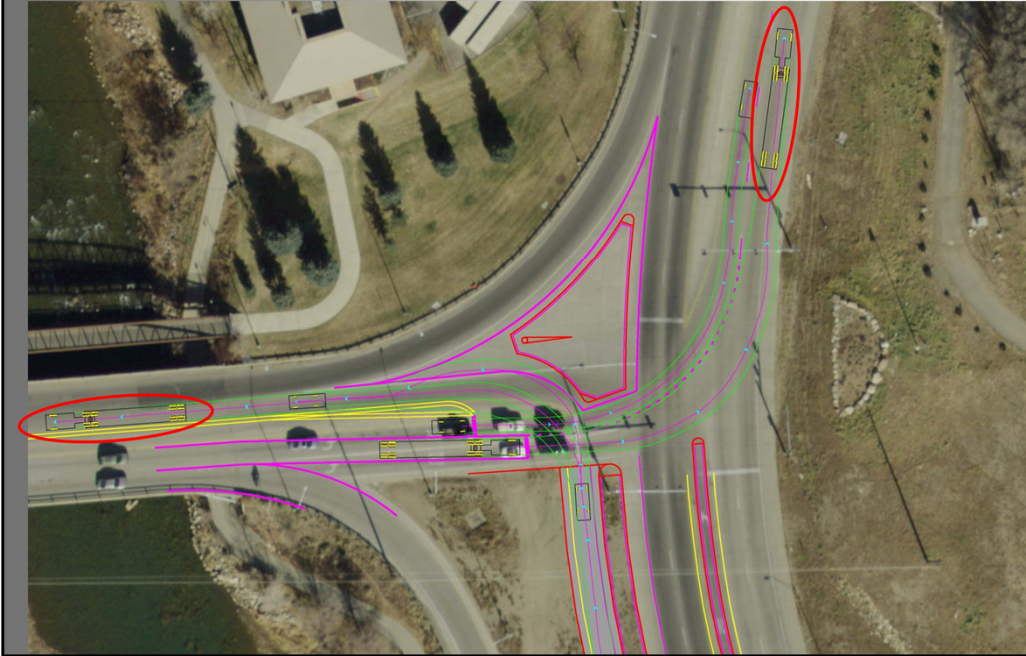
If necessary, the NB left turn lane can be extended to the south towards Santa Rita (i.e. remove and relocate existing concrete barrier).

Advance Signing



People have expressed a concern with vehicles missing the northbound left turn crossover of southbound traffic. Options include enormous signs that hang over the roadway, as is shown in this picture of a large overhead sign on the interstate (notice the large tractor trailer that is ~50 feet further down the road than the overhead sign.) Other options include large signs mounted on posts along the right hand side of the roadway.

Large Trucks



This is an example of how truck turning modeling software is used to design the northbound left turn at the CFI to accommodate large trucks. The trucks circled are large tractors with a 53' trailer, which is the typical semi truck used by Walmart or Albertson's. Paint is geared for delineating where cars need to go, the truck turning modeling is used to allow room for trucks to turn without colliding with curbs or tracking off of the paved roadway.

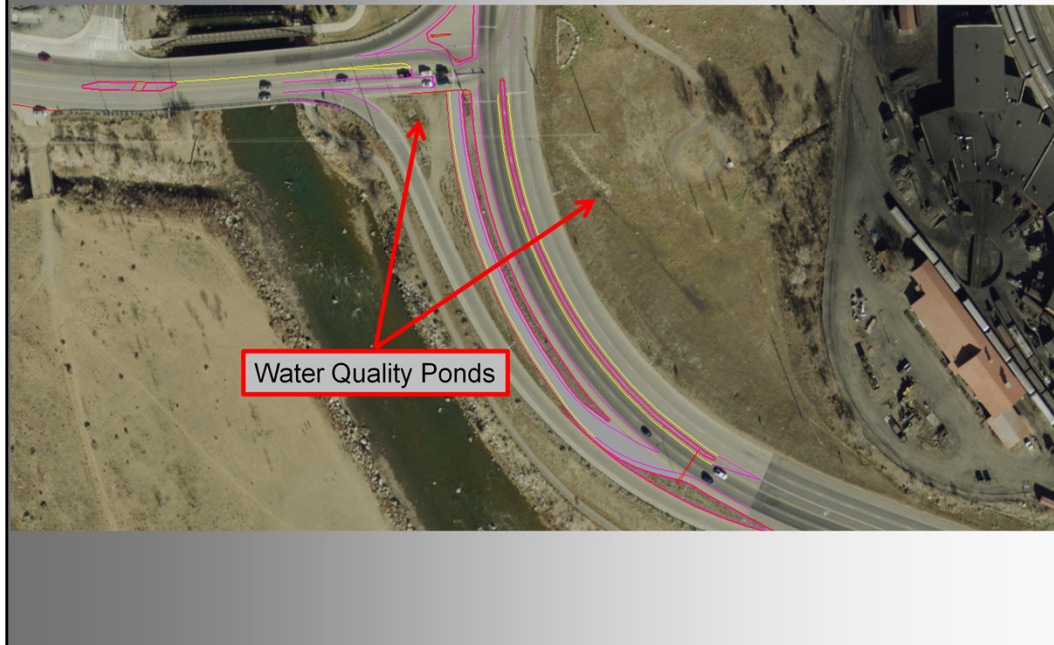
This slide also shows using the painted median space for one of the two eastbound US 160 left turn lanes. The eastbound (EB) lane configuration would then be:

The 1st left turn lane would be within the median space from the 160/550 intersection back to Roosa

For the existing two EB lanes approaching the intersection, the inside lane would be the 2nd left turn lane, and the outside through lane would become a dedicated right turn lane with striping and signing in advance of the right turn indicating that the right lane must turn right.

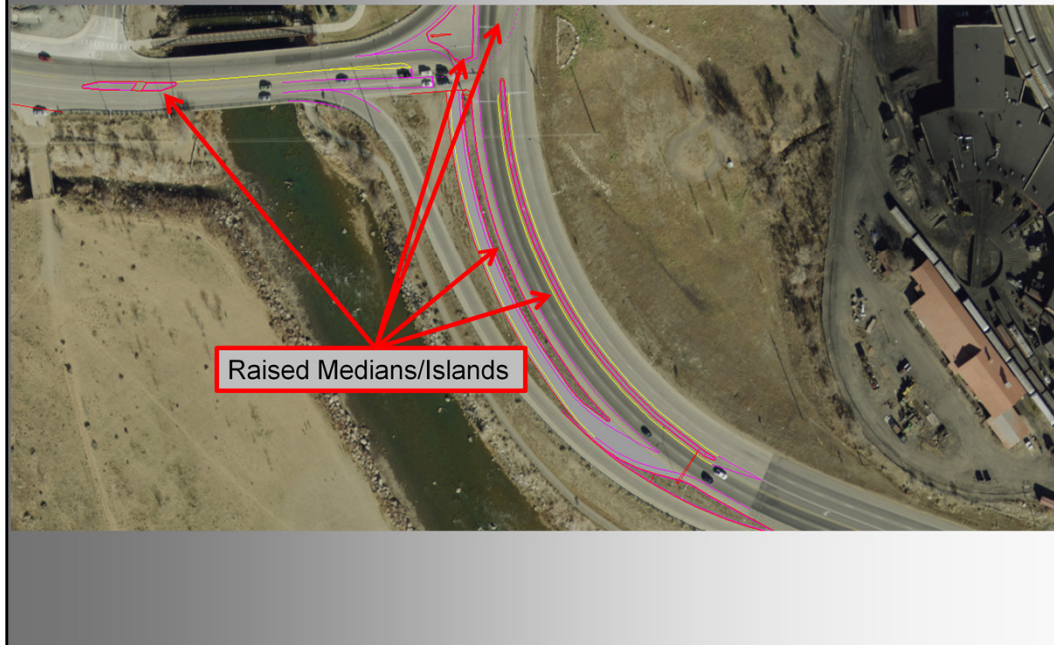
Currently the outside EB lane is a left turn lane and during the busier times of day it blocks the EB right turns, which impedes both the number of left turns that can make it through the light and right turning vehicles. The reconfiguration of the lanes discussed above will improve the EB movements and make the moving of the EB stop bars to accommodate the CFI a non-issue.

Water Quality



Roadway storm water runoff from rain and snow must be treated before being discharged into the Animas River. The arrows show locations of detention ponds, which will be similar to those seen through Bodo, that will provide a level of treatment of storm water runoff. The pond on the east side of the intersection will not only treat highway runoff, but will also treat stormwater runoff from the railroad yard.

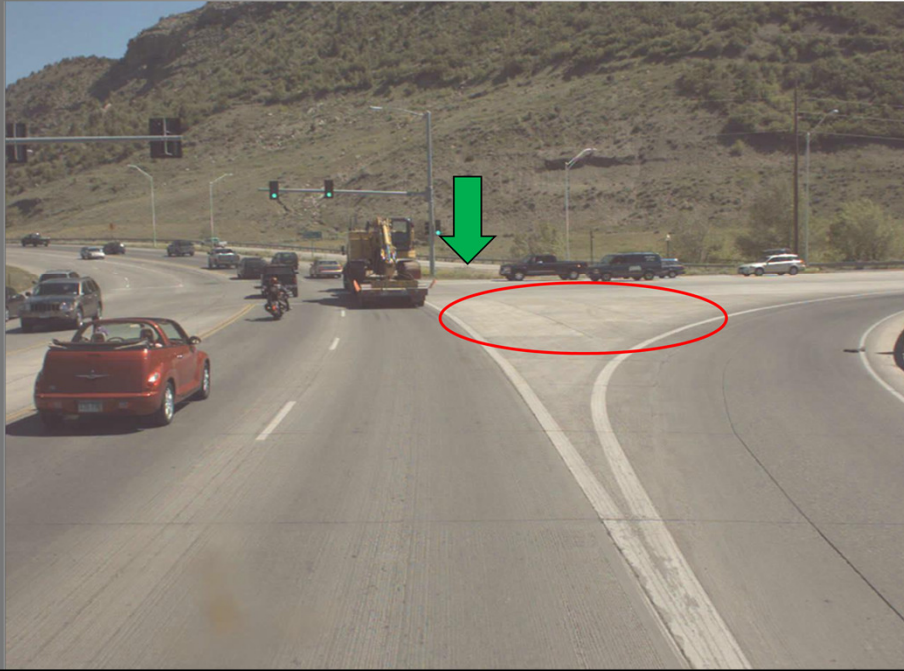
Raised Medians/Islands



The arrows on this slide show potential raised curbed islands and medians, some of which are being discussed as locations for landscaping to provide gateway treatments into Durango. Snow removal for areas with the proposed raised medians/islands is not that different to areas without raised medians/islands. Snow is typically plowed to the outside of the roadway. If there is a curb along the outside of the roadway, the majority of snow is plowed up and over the curb. The 20" proposed tall curb is shorter than the typical 27" tall metal guardrail, and most snow makes it up and over metal guardrail. After the first snow plowing of the season, the windrow of snow between and behind the guardrail posts refreezes, and very little additional snow makes it in between the guardrail posts. Snow that falls or is plowed on the raised medians/islands is typically left there. For the sections of the project that have patterned concrete, the project is considering constructing an invert in the patterned concrete to direct snow melt to landscaped areas within the median/islands or to drainage structures. This would reduce snow melt within the medians sheeting and refreezing across adjacent travel lanes. The CDOT maintenance crews that plow the snow within this segment of roadway are participating in the design of the project.

More on gateway treatment on the following slides.

Landscaping



The green arrow shows the approximate location of the CFI left turn lane at the west junction of US 160/US 550. The red circle shows the proposed location of a large raised curb triangular shaped island, that could fit within the current painted island. Prior to this project, the City of Durango has expressed an interest in landscaping at this location. Here the island could provide a landscaped gateway treatment, better delineation of the edge of the southbound through lanes, make it more difficult for the southbound traffic to mistakenly enter the CFI northbound left turn lane, and mitigate headlight glare between opposing directions of traffic.

The majority of CFI's across the country do not have measures to hide the CFI left turn lane from opposing traffic. Typically for CFI's the only measure to prevent wrong way entry by opposing traffic into the CFI left turn lane are signs, and the CFI's that are in place function very well. However, it is felt that for this project it would be beneficial to have the triangular shaped raised island to also help prevent wrong way entry and to also function as a gateway treatment.

Landscaping



The green arrow shows the approximate location of the CFI left turn lane south of the west junction of US 160/US 550. The red circle shows the proposed location of a long raised curbed island that could also be used for landscaping as a gateway treatment. Similar to the triangular island on the previous slide, the island could provide a landscaped gateway treatment, better delineation of the edge of the southbound through lanes, and the landscaping can be utilized to mitigate headlight glare between opposing directions of traffic.

The majority of CFI's across the country have standard 6" curb with concrete in between, as well as higher speeds, and the CFI's function very well. However, it is felt that for this project it would be beneficial to have a landscaped long raised island to hide the CFI turn lane and a gateway treatment.

Gateway

- *Features- Landscaping, trees, large signs, narrowing roadway (physically or perceived)*
- *Effect- Traffic Calming*



A gateway treatment consists of visual cues that indicate changes in roadway character from high speed busy major urban road to a lower speed city street with adjacent roadside businesses and a higher percentage of pedestrians and bicyclists using the roadway and roadside areas. Over the years the City of Durango and CDOT have partnered for the installation of the gateway features (large sign, trees, flag) on the right hand side of the photograph. The red circles show some of the possible locations for a raised curbed median that could be landscaped as a gateway treatment. The project is proposing to locate gateway features within current paved roadway space to visually break up the roadway and provide a better gateway treatment.

Although CDOT owns the property to the fence line east of the intersection as well as a large portion of the grassy/landscaped area between the roadway and the Doubletree Hotel, CDOT Region 5 does not maintain the landscaping. CDOT Region 5 does not receive funding for landscape maintenance, thus for landscaping to occur a partnership with entities outside of CDOT, as has been done in the past, is necessary. CDOT and the City of Durango are partnering with respect to possible landscaping and its associated maintenance.

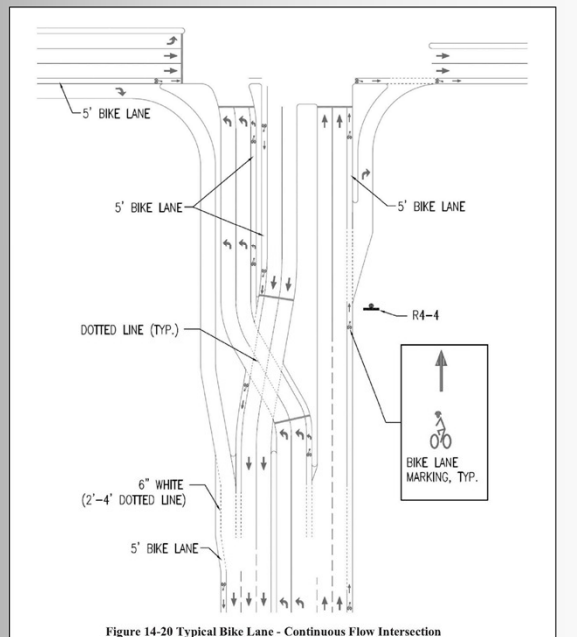
A concern by a Durango City Councilor with respect to deer grazing on vegetation within the median and causing accidents was raised at the 1-2-13 Public Hearing. The following was presented in response:

1. Vegetation will be carefully selected to minimize its attractiveness to deer.

2. The low-speed, posted 35 MPH, environment makes it easier for driver's to avoid wild animal collisions vs. higher speed locations.
3. The project is within an urbanized environment, and while deer are still present, they are less prevalent than in more rural areas making accidents less likely than in other areas.
4. None of the injury accidents discussed later in this presentation involved wild animals, so there is no significant current issue, making future issues unlikely.

Bicycles

- CFI Bike Lane
- Bicycle Detection



At the 12-12-12 public meeting, a reallocation of roadway space for the Camino del Rio portion of the project (See proposed typical sections later in this presentation) was discussed for creating space for bike lanes on Camino del Rio. Public comments requested that the project include additional on-street bicycle accommodations for the entire project. This statement was echoed by the public at the 1-2-13 City Council Public Hearing on the Access Control Plan Amendment in the vicinity of 7th Street. This slide was shown at the 1-2-13 hearing, and shows an engineering recommended practice for accommodating bike lanes through a CFI intersection. Also discussed was that the non-invasive (i.e. does not require cutting up pavement for installation) vehicle detection technology proposed for use on the project (several vehicle detection zones will need to be relocated) is capable of detecting bicycles if they are the only vehicles present within the vehicle detection zone. Other possibilities for accommodating bicycles throughout the entire project are currently being researched. A meeting with City of Durango Multi Modal Department and public bicycling advocates was held on 1/14/13 to discuss options for accommodating bicycle turning movements in all directions at the CFI intersection, the intersection of College/Camino, ways of providing bicycle left turns that do not require weaving across two through lanes of heavy traffic, the links between the intersections, and extending the bike facilities along each leg of the intersection for some distance.

Traffic Modeling

- Worst Queue Length

Table 3: 2011 PM Peak Hour Analysis – Worst Queue Length								
Intersection	Existing		Improvements to College Only		Improvements to US 550 / US 160 Only		Improvements to Both	
	Movement	Queue	Movement	Queue	Movement	Queue	Movement	Queue
US 550 / US160	NBL	1,131	NBL	1,670	EBL	283'	EBL	288'
College	WBL	769	WBL	415'	WBL	864'	WBL	407'

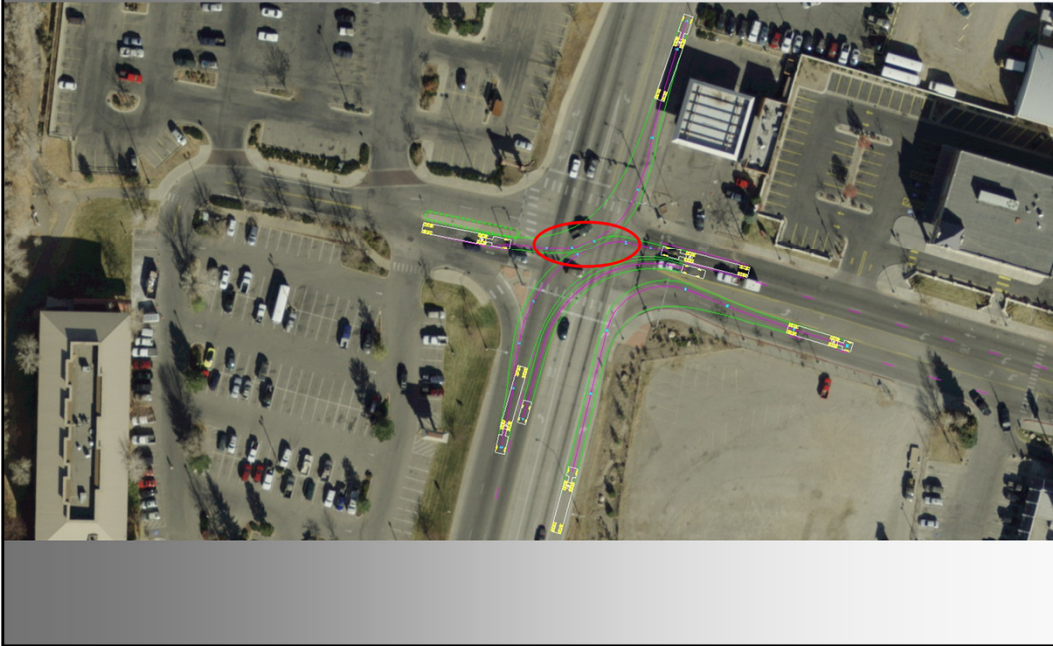
Source: Fehr & Peers, September 2011

This chart is a worst queuing (stacking of vehicles during a red signal indication) analysis using current summer PM traffic volumes (busiest time of day, busiest time of year) and the same volumes used in the traffic model animation. The red circle on the left shows the existing US 160/550 and College/Camino intersection worst queue lengths. The red circle on the right uses the same traffic volumes and shows how queue lengths are improved with the CFI and College/Camino improvements.

Because of the close proximity between the west junction of US 160/550 and the intersection of Camino del Rio (US 550)/College, improvements are needed at both intersections to have the best long term effect, and improvements to only one of the intersections worsens the condition at the other intersection. Improvements at both intersections are necessary to have the greatest positive effect.

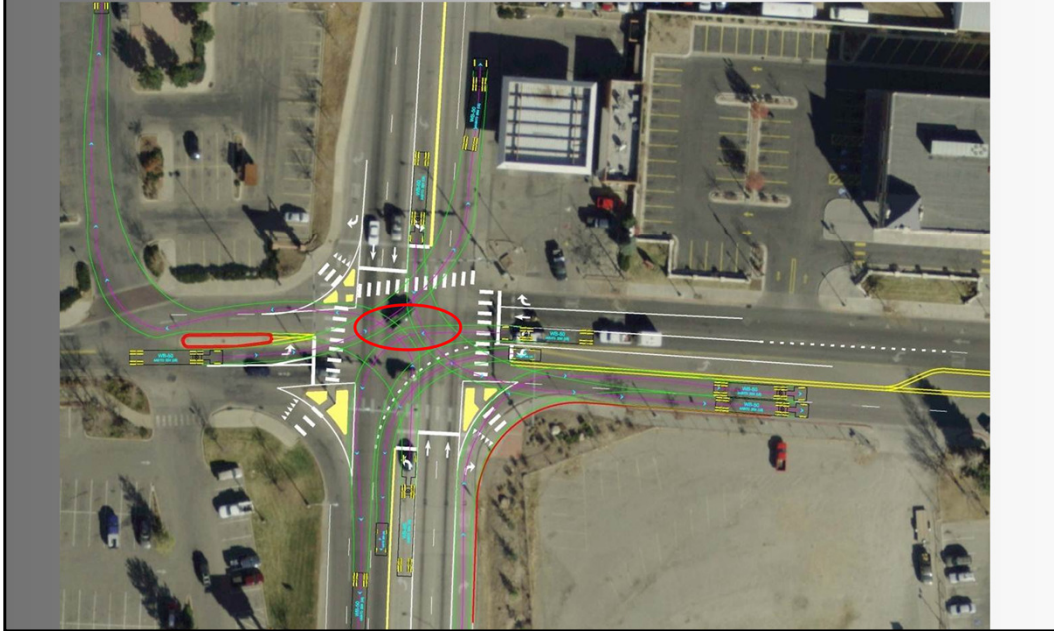
Improvements at both intersections greatly improve current traffic conditions, and it will be 10 years before traffic returns to the traffic congestion levels of Today. If nothing is done and these two intersections are left as is, traffic congestion ten years from now will be significantly worse than it is Today.

US 550 (Camino del Rio) & College Dr. Existing



Camino del Rio (US 550) and College Dr. Intersection-
Current intersection does not allow for simultaneous left turns from College east and west, which limits what movements through the intersection can occur at the same time (conflicting movements can never receive a green indication at the same time). This has a direct impact on signal operation efficiency.

US 550 (Camino del Rio) & College Dr. Proposed



US 550 (Camino del Rio) and College Intersection-

The red line in the bottom right quadrant shows the proposed minor widening (about the width of the existing sidewalk). This allows a restriping and reallocation of space for westbound College that allows for two left turn lanes, a through lane, and a right turn lane. Two inbound lanes to downtown will also be maintained. This lane configuration matches the lane configuration proposed by the Railroad Square development. When westbound traffic is not blocking the entrance to Wells Fargo, vehicles will be able to make a left hand turns into Wells Fargo from the inside through lane. Left hand turns from the inside through lane is the same way left hand turns are made off of College Dr. to 2nd Ave through , 8th Ave, or left hand turns off of Main Street to 7th through 13th Streets. Additional triangular shaped islands are proposed to reduce pedestrian crossing distances of the intersection and other sidewalk improvements will be necessary for the intersection reconfiguration.

US 550 (Camino del Rio) & College Dr. Right Turn Raised Crosswalk



At Camino del Rio (US 550) and College Dr. raised crosswalks are proposed to provide traffic calming of the right hand turns and to facilitate pedestrians crossing from the sidewalks to the triangular shaped islands.

Camino del Rio (US 550)/ College Traffic Model



See video link on website.

This model uses current summer PM peak traffic volumes and incorporates the CFI and proposed College/Camino del Rio intersection improvements.

Raised Medians

- Existing Access Control Plan (ACP)



This is an exhibit from the current CDOT/City of Durango Access Control Plan that was approved by both agencies in 2009. The red circle highlights that a future pedestrian crossing was desirable between 7th Street and 8th Street, but that the exact location was not yet determined.

Raised Medians

- Current Pedestrian (PED) Crossings with Rapid Rectangular Flashing Beacons



Camino del Rio (US 550)/ 7th ST RRFB

This is a picture of the current rectangular rapid flash beacon (RRFB) at Camino del Rio (US 550). Improving a pedestrians crossing on a road as busy as Camino del Rio (US 550) in the vicinity of the project, which at 35,000 Annualized Average Daily Traffic carries nearly identical volumes as Federal Blvd (US 287) in Denver Colorado near Mile High Stadium, is extremely challenging. It takes more robust and innovative measures than what has been used in the past. In fact, studies have shown that the conventional measures of striping a crosswalk and installing conventional signs on roads as busy as Camino del Rio result in *more* pedestrian injury accidents. Stronger measures are necessary to facilitate pedestrian crossings.

The rapid flash beacon at 7th is a newer measures for facilitating pedestrian crossings that is nationally recognized, and has been proven to be far superior to painting a crosswalk and having regular road signs without lights. Yellow lights and yellow signs are a nationwide sign of caution to motorists. The strobe lights at theses signs are activated by a pedestrian pushing a button. Other adjacent signs remind motorists that it is STATE LAW to yield for pedestrians within a crosswalk. Yielding for pedestrians at crosswalks is STATE LAW regardless of whether or not there are signs with or without strobe lights to catch motorists attention. However, on busy, multilane roads motorist seldom yield to pedestrians without additional measures to catch their attention. CDOT and the City of Durango feel that the two current strobe signs on the far outside of the roadway with strobes are still insufficient to catch motorist attention to get them to comply with state law, and that further improvements are necessary.

Raised Medians

- Pedestrian Crossings with Refuge + RRFB



Typical City of Boulder RRFB Installation

This is an example of the additional improvements proposed for the rectangular rapid flash beacon at the 7th Street crossing. This picture is a successful RRFB installation by the City of Boulder on a busy 4 lane state highway. A raised curbed median breaks up the pedestrian crossing into two stages. The 4 through lanes each have strobe light signs in the direct line of sight of motorists. A yield line, triangular shaped pavement markings, with yield here to pedestrian signs indicate to motorists to stop further back from the painted crosswalk to open adjacent through lane sightlines to pedestrians in the crosswalk. To cross, a pedestrian pushes a button to activate the strobe signs for the adjacent direction of traffic. Once traffic yields to the pedestrian per STATE LAW, the pedestrian crosses to the raised curbed median refuge in the center of the roadway. In the median the pedestrian pushes a button to activate the warning lights for the other direction of traffic, and can complete their crossing once traffic yields the right of way per STATE LAW. The push buttons at the roadside and within the median will have a 1-3 second delay before activating the warning lights to encourage pedestrians to ensure traffic is stopped before proceeding. There will also likely be an ~30 second delay between simultaneous activations of the full crossing to allow traffic to clear. The City of Durango was investigating grants to make these additional improvements, however, the proposed CFI project provided a possible means of incorporating these improvements as part of the CDOT funded project.

Raised Medians

- 7th Street Pedestrian Crossings with RRFB



This is a sheet showing the additional improvement to the rectangular rapid flash beacon pedestrian crossing at 7th Street.

Since painting crosswalks and conventional signs have been proven to be ineffective on roads as busy as Camino, other means for facilitating pedestrian crossings are necessary. A discussion on different treatments is provided below:

1. Pedestrian Overpass/Underpass- An overpass or underpass can be great tool for facilitating pedestrian crossings of busy roads. Underpasses have been used successfully in Durango to cross the Animas River Trail under N. Main, US 160 near the Doubletree Hotel, US 160/550 near Santa Rita Park and near the Humane Society. The main drawback for these types of crossings is their immense cost. If the crossing is combined with a major roadway crossing of a river such as the examples listed above, an underpass is still very costly, and without the ability to combine with a river crossing it becomes even more costly. An underpass of Camino in the vicinity of 12th Street (HAWK vicinity) was studied and presented to the public in 2009, but due to funding limitations and a lack of consensus among the public the study was put on hold. Also, the design of a pedestrian overpass or underpass funneling and encouraging people to use the crossing is critical. Every mode of transport is looking for the shortest, most timely, direct route. Out of direction travel often takes more time on foot, to include ramps up to an overpass or down to an underpass. If an overpass/underpass is not designed adequately it will not only be costly, it will be a waste if people do not use it, and you will end up with the same pedestrian roadway crossing issues and concerns. There is a trail underpass of US 160 from Roosa to the Dog Park, but it does not funnel

users to it and requires significant improvements to encourage people to use it. Many people still choose to cross US 160 vs. using the underpass. While a significantly improved underpass from Roosa to the Dog Park is in the long range plan for the City of Durango, this project proposes to also install an RRFB with median pedestrian refuge from Roosa to the Dog Park as an interim measure to facilitate pedestrian crossings. One thing to remember with very costly solutions is that funding and implementing them is inherently difficult because of the cost *and* it leaves less available money for other locations that are also in need of improvements.

2. Full Traffic Signals- Full traffic signals have their pros and cons and must meet warrants (signal warrants are nationally recognized criteria to ensure that the benefits of installing a traffic signal outweigh the negatives). Warrants, cost, the fact that signals are significant locations of conflict and accidents, operational impacts of signals that are too closely spaced, etc. all contribute to why a traffic signal cannot be installed at every intersection. While a warrant exists for installing a full traffic signal based on pedestrian volumes, the pedestrian volumes necessary to satisfy the warrant often exceed the pedestrian volumes at the location.
3. Pedestrian Hybrid Beacons (a.k.s HAWK Signal) and Emergency Vehicle Hybrid Beacon- HAWKs are a nationally recognized means for facilitating pedestrian crossings on busy major roadways (Tucson, AZ pioneered HAWK's and has successfully used them on 6 lane roads, with higher speed limits that carry 60,000+ vehicles). A HAWK is the current system in place at Camino del Rio near 12th Street to facilitate pedestrian crossings and Emergency vehicles entering Camino. These systems are formally known as hybrid beacons because they do more than a normal flashing beacon, but they aren't quite a full traffic signal. The pedestrian volume necessary to satisfy the warrants for a HAWK is far less than that for a full traffic signal, making it easier to justify their installation. An Emergency Vehicle Hybrid beacon looks and functions the same as a HAWK and is now also a nationally recognized means for facilitating emergency vehicle entry on to busy roads. The pros of a HAWK include red signal indications are given to motorists to get them to stop, the pedestrian receives the same walking person, flashing/steady upraised hand indications they are accustomed to at other signalized intersections, hybrid beacons can be used for pedestrians and emergency vehicles, they can be coordinated, etc. For these reasons and because the majority of the signal infrastructure was already in place from the previous emergency signal, a HAWK was selected for the pedestrian crossing treatment at 12th St and Camino del Rio. However, HAWK's also have cons. Initially the HAWK near 12th street would activate within a couple of seconds of a pedestrian push button activation. While this was a great response to pedestrians, multiple back to back activations was causing significant back ups, complaints, and increasing driver non-compliance. The HAWK was then coordinated with adjacent signals, the recommended practice. Initially coordination was on a full cycle to match the signalized intersections in the vicinity of the at 100-140 second cycle lengths. Full cycles resulted in pedestrians waiting up to ~1.5 to ~2 minutes for a walk indication. With the up to 100 -140s pedestrian wait times, people were activating the push button, crossing during a gap in traffic, and the HAWK signal sequence would later activate long after the pedestrians had crossed and were out of sight. The signal sequence activating with no pedestrians in

sight was creating issues with driver's accepting and complying with the signal indications. The HAWK signal now runs on half cycles of 50-70 seconds. Half cycles at the HAWK maintain signal coordination and provide half the wait time of a full signal cycle for pedestrian activations. Changing to half cycles for the HAWK has helped with the correlation of signal indications and a pedestrian activation, but pedestrians still activate the hawk and do not wait for the walk symbol to cross. HAWK indications comply and are consistent with motor vehicle codes across the US. The Colorado Driver's Handbook states: "FLASHING YELLOW LIGHT: a flashing yellow light is a warning." A flashing yellow light means driver's need to pay extra attention and be sure to follow the rules of yielding the right of way (i.e. The RRFB has flashing yellow lights as a warning to driver's who must yield to pedestrians in crosswalks per STATE LAW). At a HAWK the flashing yellow is a warning, just like any other flashing yellow it is a warning, and indicates that the signal has been activated and is going into its signal sequence. "STEADY YELLOW LIGHT: A red light is about to appear. Stop unless you are already within the intersection." A HAWK steady yellow is the same as any other steady yellow and means the light is about to go red. "STEADY RED LIGHT: STOP" the steady red light at a HAWK is the same as at any other signal, stop and stay stopped during the steady red. "FLASHING RED LIGHT: A flashing red light means the same as a STOP sign." The flashing light at a HAWK is the same as a stop sign. At a stop sign all vehicles must come to a full and complete stop, and after coming to a full and complete stop they may only proceed if it is clear to do so (i.e. for the Camino HAWK no pedestrians or emergency vehicles are crossing). If you are the second car at a stop sign, once the car in front of you proceeds, you still have to come to a full and complete stop, even if it appears that it is clear to go through the intersection. The flashing red seems to be the most misunderstood signal indication, at the HAWK the 2nd and subsequent driver's proceed through the intersection without stopping, and some driver's do the opposite, they remain stopped during the entire flashing red even if it is clear to proceed. Just remember, "A flashing red light means the same as a STOP sign."

4. Rectangular Rapid Flash Beacons- This system was pioneered in its current form in St Petersburg Florida, and again has been used on busy multi lane roads across the country. The pros of the RRFB with pedestrian refuge have been discussed on previous slides. Also, a RRFB system has a quicker response time to pedestrian activations than a conventional signalized intersection or HAWK signal. The typical 1-3 seconds, or even the worst case ~30 second, response to pedestrians time of the proposed RRFB upgrade is far quicker than the HAWK or traffic signals. While an RRFB does not lend itself to coordination with adjacent signals, the RRFB impacts only one direction of traffic at a time, provides shorter pedestrian crossing distances of two lanes to the median refuge area, which in turn requires less strobe flashing time than what is required to cross 5 lanes, and traffic being able to proceed with caution once pedestrians have cleared to the refuge area or sidewalks all reduce the impacts to traffic. Another pro is that an RRFB is less costly than any of the other options listed above. Given that available funding is always limited and that there is no shortage of transportation systems in need of improvements (motorized vehicle, pedestrian or bicycle improvements), a system that facilitates pedestrian crossings and costs less has obvious advantages. It also leaves

more available funding for other improvements. While painted crosswalks and regular signs are the even cheaper, they *do not work* on busy multi-lane roads. The current RRFB at 7th with super bright rapidly flashing strobe lights has helped with motorists yielding to pedestrians, feel free to ask anyone who uses the RRFB on a daily basis. However, the City of Durango and CDOT believe that the proposed RRFB improvements will further significantly increase the number of vehicles yielding to pedestrians in the crosswalk per STATE LAW, providing a safer and more usable pedestrian crossing.

Raised Medians

- ACP Amendment (Option 1)



Option 2 on the following slide was the option approved by the Durango City Council on 1-2-13

~~Possible median configuration to provide sufficient median space for pedestrian refuge. East and West side of 7th Street allow for right turn in and right turn out movements. 7th Street left turn in, left turn out and through movements would need to use College and Camino del Rio signalized intersection, 1 block away, or the many other options available to/from the east side of Camino del Rio.~~

~~Pro-~~

~~Room for median pedestrian refuge~~

~~Maximize SBL 10 year traffic projections result in 600' queue lengths, which is more than what is shown, however if traffic grows to this extent there will likely be far greater traffic issues than insufficient left turn lane storage for the SBL Camino del Rio to College Dr. Virtually eliminates all left turn and through accidents at 7th~~

~~Con-~~

~~No road grid on west side of Camino del Rio, which further limits options for northbound traffic to access to businesses on the west side. There is a grid road system on the east side of Camino del Rio which provides multiple access options. Many passenger vehicles have the steering ability to easily make U-turns on Camino del Rio, which can be performed at signalized intersections with a protected green arrow.~~

Raised Medians

- ACP Amendment (Option 2) **Approved**



This option was approved by the Durango City Council on 1-2-13

Another possible median configuration to provide sufficient median space for pedestrian refuge. This option recognizes the limited access options and lack of a grid road system on the west side of Camino and allows for left turns in to the west side of 7th. Based on the limited road network infrastructure, and on meeting one on one and in small groups with businesses, this is the recommended option.

East side of 7th Street allow for right turn in and right turn out movements.

West side of 7th Street allows for right turn in, right turn out, and left turn in movements.

Any movement that only deals with one direction of traffic is simpler and safer. Through and left turn out side street movements deal with both directions of traffic, and on busy streets are more safely performed at signalized intersections. The left turn out from west side of 7th has long been prohibited by signing, the median reinforces the prohibition.

The other 7th Street movements would need to use College and Camino del Rio signalized intersection, 1 block away, or the other options available to/from the east side of Camino del Rio.

Pro-

Room for median pedestrian refuge

Allows left turns in on west 7th

Still restricts the more dangerous through and left turn off of 7th street movements that

must contend with both directions of Camino del Rio traffic.

Con-

Shorter SBL- 10 year traffic projections result in 600' queue lengths

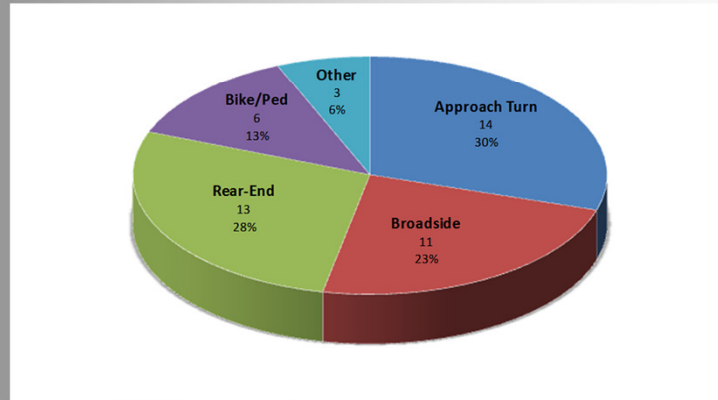
More conflict points than Option 1.

Raised Medians

Injury Accidents 1986-2011

College Dr. to 8th St

- 46 Injury Accidents, 56 People Injured
- 1 Fatality
- 330 PDO



Raised medians reduce all of the above accident types

Chart shows injury accidents on Camino del Rio between College Dr. and 8th Street. These are family and friends that have been sent to the hospital as a result of traffic accidents. PDO=Property Damage Only accidents. While not as severe as injury accidents, often the only factor that keeps a PDO from becoming an injury accident is fractions of a second.

As shown in the chart, the leading injury accident types are:

1. Approach Turn- All of these were vehicles making left turns on to Camino del Rio from the side streets College, 7th and 8th. The proposed raised median at 7th prevents left turns from 7th to Camino del Rio, which will help reduce this accident type.
2. Rear End- This accident type increases as congestion increases. Vehicles enter and exit the roadway at, and cause adjacent vehicles to travel, differing speeds. The speed differential creates an accordion affect in the flow of traffic that contributes to congestion. While traffic signals will always result in stop and go and are also a factor in congestion, more uniform speeds result in smoother traffic flow and reduced congestion. By reducing the number of locations vehicles can enter and exit Camino del Rio, raised medians can help create more uniform speeds. Uniform speeds and smoother traffic flow should NOT be confused with higher speeds. No one is advocating higher speed limits on Camino del Rio.
3. Broadside- Traffic making a through movement or left turn in front of crossing traffic. The proposed raised median will help reduce this accident type by reducing the number of locations where these vehicle movements are possible.
4. Bicycle and Pedestrians- Although bicycles and pedestrians have different needs, the results of a vehicular vs. pedestrian or bicycle injury accident are similar. In short, the bicycle or pedestrian loses against motorized vehicles in an accident. Although

Bicycles + pedestrians account for a very small percentage (likely less than 1%) of total volume, they are at 13% the fourth leading injury accident type. The proposed raised median with refuge area will help facilitate pedestrian crossings and reduce this type of accident. The reasons for vehicle vs vehicle accident reduction discussed above also apply to vehicle vs. bicycle accidents. Also, the space available within the refuge will accommodate a bicyclist wishing to use the crossing.

Movements across or left turns on to Camino del Rio are safer at signalized intersections where traffic is stopped in order to allow side street traffic to cross or enter.

Raised Medians

- Safety Benefits Raised Median vs. Two Way LT Turn Lane (NCHRP 420)
 - Average of 27% fewer accidents
 - Vehicular, bicycle and pedestrian accidents
- What happened when the medians were removed? (4 yrs. Before vs. 4 yrs. After)
 - Injury Accidents Increased **50%**
 - Traffic Volumes Increased 16%

Nationwide studies have shown that roads with raised medians have fewer accidents than roads with two way left turn lanes (A two way left turn lane is the current condition of Camino del Rio.) NCHRP 420 = National Cooperative Highway Research Program Report 420, which is a comprehensive report that discusses different roadway median space treatments.

Raised curbed medians were in place on Camino del Rio, but were removed in the early 90's with the project that installed the concrete pavement. Injury accidents increased significantly with the removal of the raised curbed medians, and increased by a far greater percentage than the increase in traffic.

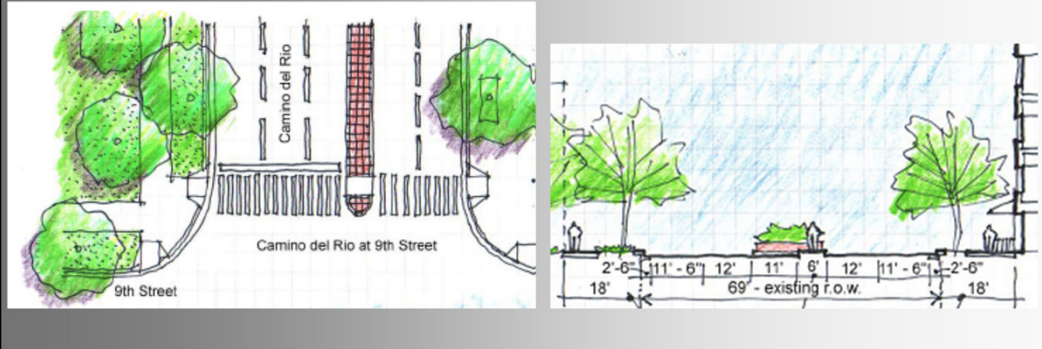
Raised Medians

- Businesses
 - Safe and efficient roads benefit all road users *and* the businesses along them
 - Countless examples across the country of roads with medians and thriving businesses
 - Met in person with 12+ businesses and organizations

Businesses are initially hesitant with respect to raised curbed medians; however, there are countless examples of roadways with raised curbed medians and thriving businesses. CDOT and the City of Durango jointly met in person with the businesses in the project area to help determine which median configuration at 7th street to propose. Other aspects, such as signing for allowable u-turns, can be incorporated into the project and were the result of discussions with businesses.

Raised Medians

- 2002 US 550 Concept Plans
- 2006 Downtown Durango Vision and Strategic Plan (Pg. 17)
 - Raised Medians 6th Street through 14th Street
 - Priority 2



Re-installing medians has been recommended by numerous City of Durango and CDOT/City Studies with public participation.

Raised Medians

- 2009 US 550 (Camino del Rio) Access Control Plan
 - Built on previous studies
 - Presented to Business Community and the Public 3 times
 - Majority of public feedback supported medians
 - Unanimous Approval by Durango City Council

Re-installing medians has been recommended by numerous City of Durango and CDOT/City Studies with public participation.

Raised Medians (Wide Section)



New York City Tall Curb Raised Median

This is a photograph of the proposed tall curb for the wider sections of the raised curbed median. The tall curb is crashworthy at the speeds vehicles travel Camino del Rio. The crashworthy tall curb will help protect pedestrians within the refuge area, prevent vehicles from crossing into oncoming traffic, and opens up more possibilities with respect to landscaping. For example, trees, which according to Nationwide studies are still by far the leading fixed object struck in fatal run off the road accidents, could be installed within portions of the tall curb raised median since the crashworthy tall curb would shield the trees.

Landscaping locations need to be considered in the design. For example, the rectangular rapid flash beacons proposed at 7th Street are of little value if they cannot be seen by motorists if the signs are blocked by landscaping. Colorado's climate is much different than this photograph of a tall curb installation in New York, so the heavy vegetation shown in the photograph is likely not possible. Landscaping would be similar to what was installed on the recent Florida Road project.

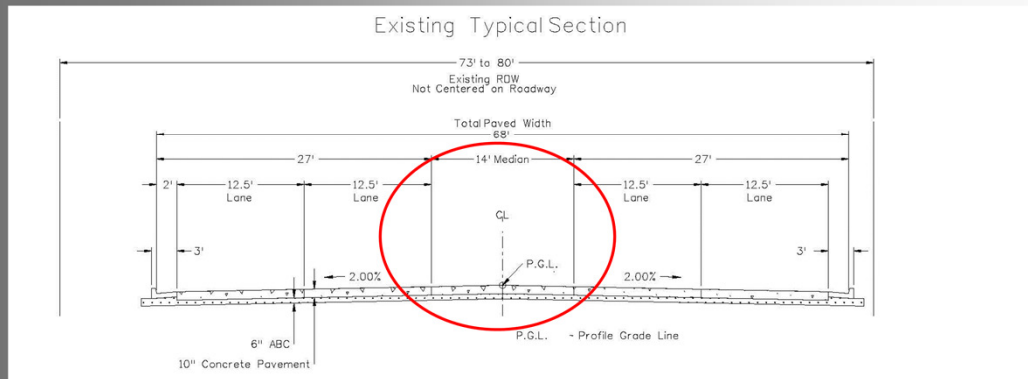
Raised Medians (Narrow Section)



Where left turn lanes are provided a narrower raised curbed median will be necessary. This photo is a local example of a narrower raised curb median.

Typical Sections

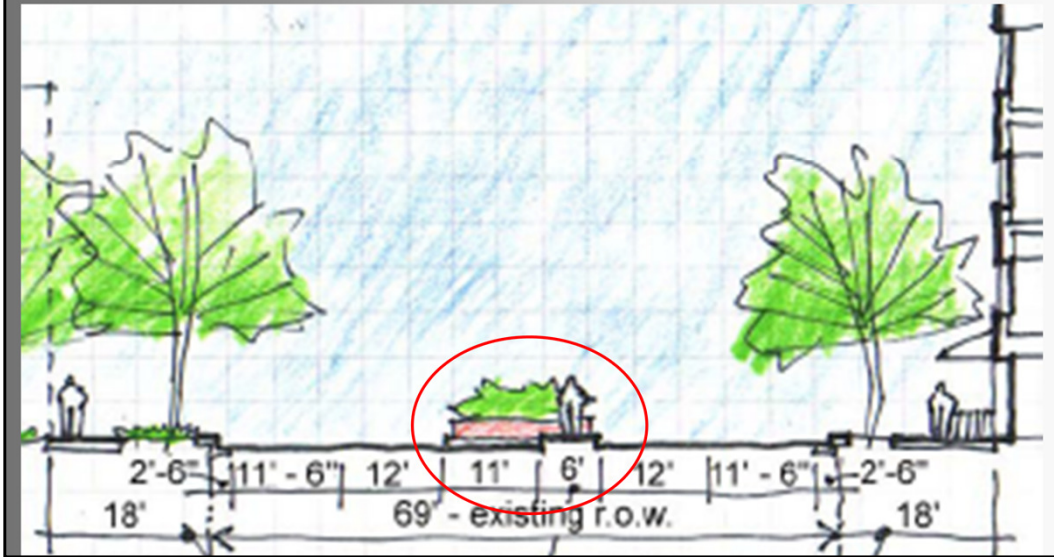
- Existing



This drawing shows the existing typical lane widths and painted median north of College Drive.

Typical Sections

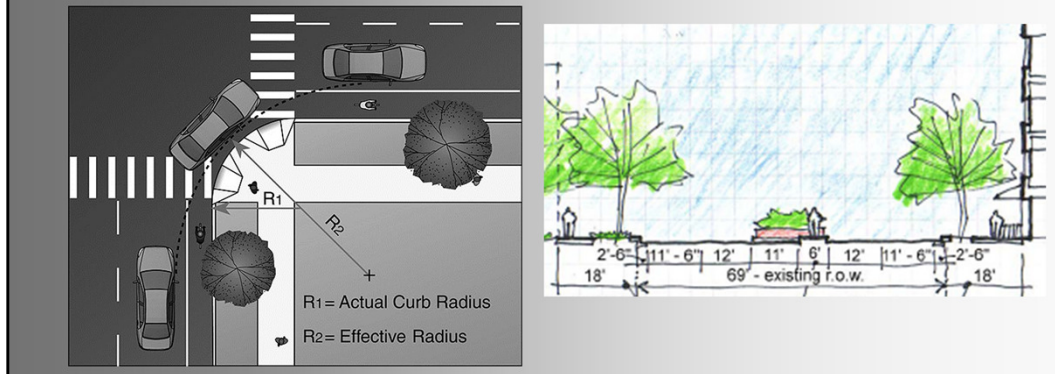
- 2002 and 2006 Studies



The 2002 and 2006 studies showed 17' raised medians with raised planters in the wide sections. The drawing shows 6' wide raised 6" tall curb medians where turn pockets are provided for pedestrian refuge at unsignalized locations.

Typical Sections

- Concerns with 17' Raised Median
 - Emergency Response
 - Absolute Minimum, non-shielded Ped Refuge
 - Bicycles
 - Effective turn radius for vehicles



This slide discusses some of the concerns with the 17' wide raised planter medians.

1. The 17' median provides 25.5' of pavement width, which leaves little room for traffic to yield to Emergency vehicles.
2. 6' wide x 6" tall raised curbed medians is the bare minimum for pedestrian refuge space and a 6" tall curb does not shield pedestrians.
3. No space to provide a shoulder/bike lane.
4. Vehicles traveling immediately adjacent to the right hand curb require more space to enter and exit driveways, which can make driveways across sidewalks excessively wide.

Typical Sections

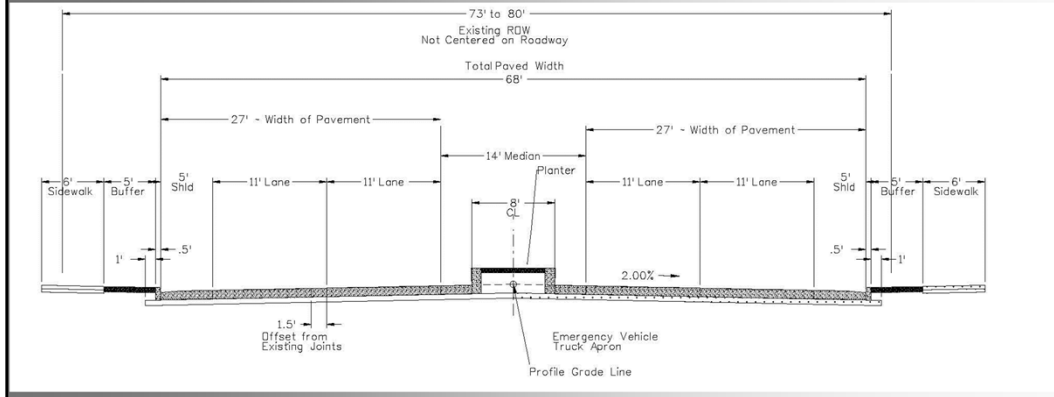
- 2009 ACP



This is a picture of raised curb medians on Federal Boulevard in Denver that was discussed as a possible example during the 2009 ACP public meetings. Federal Boulevard is very similar to Camino del Rio north of College Dr. in that it is a Colorado State Highway (US 287), has a posted speed limit of 35 MPH, and carries nearly identical traffic volumes (~35,000 AADT). Unfortunately the tiered raised curb median design is not crashworthy to errant vehicles, and tiered shapes have a tendency to vault vehicles.

Typical Sections (Current Proposed)

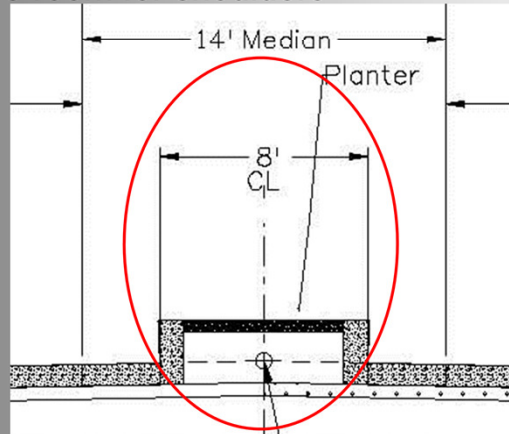
- 8' Raised Median Width
- 11' Lanes
- 5' Shoulder



Current proposed typical section. The existing right of way available north of College Drive is extremely limited. The space required for the buffer and sidewalk is not owned by CDOT or the City of Durango, thus the sidewalk and buffer improvements are not possible at this time. Properties wishing to redevelop will likely provide the buffer + sidewalk improvements. The following slides discuss the median, lane, and shoulder widths in more detail.

Typical Sections (Current Proposed)

- 8' Median Width
 - Recommended width for pedestrian refuge
 - More room for emergency response
 - Allows room for shoulders



Tall curb used in this median design (See previous picture of tall curb raised median used in new work) is crashworthy.

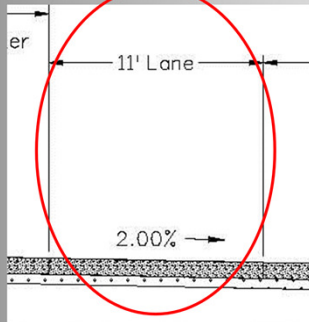
8' is the minimum recommended width for pedestrian refuge.

8' raised medians provide more usable roadway width for emergency response than the previously proposed 17' raised medians.

8' raised median width allows room for striped shoulders, 17' raised medians do not.

Typical Sections (Current Proposed)

- 11' Lanes Low-Speed Urban High Volume Road
 - AASHTO range 10'-12', 11' common with advantages
 - Reallocation of Space
 - Traffic Calming
 - Negligible differences on safety or capacity
 - Some studies show improved safety

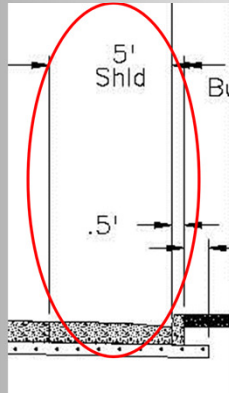


AASHTO- American Association of State Highway Transportation Officials

Typical Sections (Current Proposed)

- Benefits of 5' Shoulders

- Bicycles
- Sight Lines
- Drainage/Snow Storage
- Effective Radius
- Sidewalk Traffic Buffer



Striped Shoulders have numerous benefits-

1. Allow space for bike lanes
2. Moving lanes towards the center of the road opens up sight lines if there are visual obstructions at the roadside.
3. Helps keeps stormwater runoff and snow out of traveled lanes. Ideally for snow plowing there would be a buffer strip or wide sidewalk behind the curb to plow snow off the entire paved roadway without burying the main portion of the sidewalk. Unfortunately, CDOT owns insufficient right of way behind the curb College north to make sidewalk improvements to account for snow storage.
4. It is easier and takes less space to turn in in out of driveways if you are a distance off of the face of curb vs. right up against the curb.
5. Where there are sidewalks it moves the motorized traffic further from the sidewalk.

Minimizing Construction Impacts

- Minimize lane closures during peak hours, night work
- Construction outside of peak travel season
- Pipe Jacking
- Construction Phasing built into plans and specifications

Pipe Jacking- Shoving a pipe under the road which eliminates the need for an open trench
Fast Track Concrete- Concrete that gains strength quickly so that traffic can be placed back on it in a few hours vs. the typical necessary several days.

Outreach Efforts

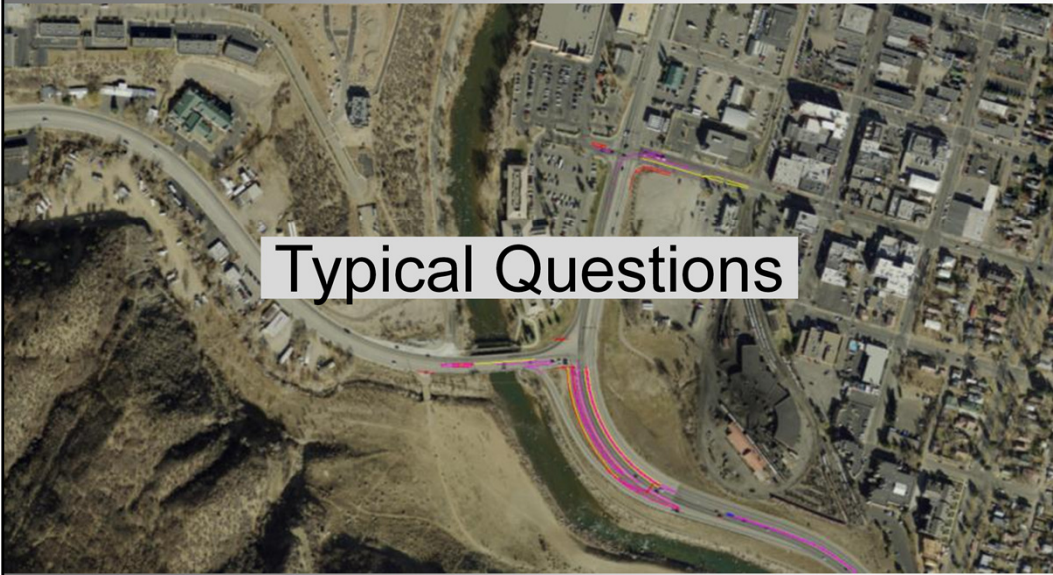
- Business Owner Meetings
- Public Meeting 12-12-12
- Durango City Council (Twice)
- Project Website
http://www.coloradodot.info/projects/us160_us550durangocfi
- Durango BID
- Durango Fire and Rescue
- Durango Police Department (Twice)
- Colorado State Patrol
- Individual Members of the Public
- Anyone who would like to discuss the project

Businesses, organizations and individuals met with-

- Albertson's
- Cocina Linda
- Denny's
- Double Tree Hotel
- Durango Adult Education
- Durango Downtown Inn
- DSNR
- Giant/Shell Gas Station
- Liquor World
- SCCC
- Southwest Conservation Corps
- Strater Hotel
- Wells Fargo
- US Post Office
- DFRA
- Durango PD
- Southwest Transportation Planning Region
- 12-12-12 Public Meeting
- 1-2-13 City Council Public Hearing, study session several weeks prior to hearing
- Several one on one e-mails, phone calls and meetings with individual citizens
- Others

West Junction US 160/US 550 Durango Intersection Improvements

Typical Questions



What About Speeds?



Reducing the speeds, perceived or actual, at which motorized traffic travel through communities is a common theme. It is a common misconception that the posted regulatory speed limit is the primary driving factor for the speeds at which people drive. In this photograph of the speed reduction to 35 MPH approaching the project, what is the primary factor causing this driver to apply the brakes? Is it the sign or is it the tight curve minimally banked and line of cars stopped at the intersection? Regardless of what the speed limit states, the majority of driver's travel at the speed they feel comfortable with for the given environment.

The Gateway treatments for traffic calming discussed earlier in the presentation are aimed at providing many more visual cues to traffic that they are entering a lower speed environment than relying solely on the posting of speed limit signs. Transitions from high speed to low speed can be problem locations, that is why the project is looking into using more than just signs to manage the transition.



In this photograph what is the primary factor causing the low speeds on Downtown Main Street in Durango? Is it the sign or is it the roadside environment, tightly spaced signals (many are more closely spaced than the two signals for the CFI), etc.? The City of Durango has published reports that the average speeds on Downtown Main Street are less than 20 MPH. Regardless of what the speed limit states, the majority of driver's travel at the speed they feel comfortable with for the given environment.

Prior to the construction of a Truck Bypass in the mid-60's, what is Today Camino del Rio (US 550), the North/South highway was Downtown Main Street. Moving all highway traffic, that has grown significantly over the years, off of Downtown Main to Camino is in large part why Downtown is a nice, comfortable gathering place for the community and visiting guests. If there was no Camino, and its current traffic used Downtown Main, you can imagine the mess that would create.

Camino del Rio (US 550) is also equipped to handle larger volumes of traffic and provide shorter travel times (fewer signals, signal coordination, fewer disruptions to smooth flow of traffic) than Downtown Main Street.

What About Speeds?



- 50 MPH Zone (Santa Rita Dr. to 35 MPH Sign)
 - 32 PDO, 6 Injury, 0 Fatal
- 35 MPH Zone (35 MPH Sign to mid-block 7th/8th St)
 - 180 PDO, 7 Injury, 1 Fatal

Similar to how Camino del Rio (US 550) handles larger traffic volumes and provides shorter travel times than Downtown Main, South Camino del Rio (US 160/550) is equipped to handle larger volumes of traffic and shorter travel times than Camino del Rio (US 550) (few signals, limited access except at signalized intersections, etc.). South Camino del Rio was also a bypass to take traffic off of SH 3, 8th Avenue, and College Dr. For this stretch of roadway the primary factor affecting speed is the speed at which people feel comfortable

Comparing the accident history for the last five years of the 50 MPH portion of the project (the only work currently proposed in this area at this time is advanced signing south of the west junction of US 160/550) Santa Rita Drive to the 35 MPH speed limit change vs. the 35 MPH speed limit change to mid block 7th/8th St:

1. The 50 MPH zone currently carries ~38,000 AADT, has 32 Property Damage Only (PDO), 6 Injury (None of the accidents involved bicycles or pedestrians), 0 fatalities.
2. The 35 MPH zone carries ~35,000 AADT had 180 PDO, 7 injury (None of the accidents involved bicycles or pedestrians), and 1 fatality.

The 50 MPH zone was built to and does carry more traffic, provides shorter travel times, and has a better safety record than the 35 MPH zone.

The Manual on Traffic Control Devices (MUTCD) is a code of federal regulations and is adopted by state statute and regulates everything from the striping on the road, to

roadway signs, to signals, etc. With respect to speed limits it states:

Section 2B.13 Speed Limit Sign (R2-1)

Standard:

01 Speed zones (other than statutory speed limits) shall only be established on the basis of an engineering

study that has been performed in accordance with traffic engineering practices. The engineering study

shall include an analysis of the current speed distribution of free-flowing vehicles.

Following requirements helps make speed limits enforceable (CDOT deals with the validity of posted speed limits, too high and too low on a frequent basis). The more dense the urban roadside environment the more factors play into the speed study to determine the speed limit. Although the speed at which the majority of driver's drive (85th percentile) is not the only factor in the urban environment for setting speed limits, it has been shown that the further from the 85th percentile a speed limit is posted the less effect it has on traffic. Looking at all factors, a properly posted speed limit has a normalizing effect and creates more uniform speeds, less speed differential is safer and causes traffic to flow smoother. Many laws in this country are based on the fact that the majority of people are reasonable and prudent in their actions. Also, if a speed limit is posted at a certain speed and the majority is driving at a different speed, what is being gained?

Law Enforcement of arbitrarily set speed limits is problematic. Not only is justifying legality an issue, but police officers can not be everywhere at all times, and speed enforcement is just one of the countless duties law enforcement is entrusted with. A speed limit that is set too low becomes an enforcement problem, and often as soon as the officer leaves so does the enforcement of the lower speed. Arbitrary speed limits with rigid enforcement can become a public relation disaster for law enforcement (Look at the debate on red light cameras that can have significant safety benefits).

To summarize, appropriately posted speed limits can have a limited benefit, but they are not the primary driving factor for the speeds at which the majority of the public drives. Other factors such as sharpness of the road curvature, the environment that the road is within, and visual cues can all have a greater effect on travel speeds. The majority of the public drives at the speed at which they feel comfortable driving regardless of the speed limit. This project is looking at additional measures besides speed limits for the transition from high speed to low speed and throughout the rest of the project to encourage desired operating speeds.

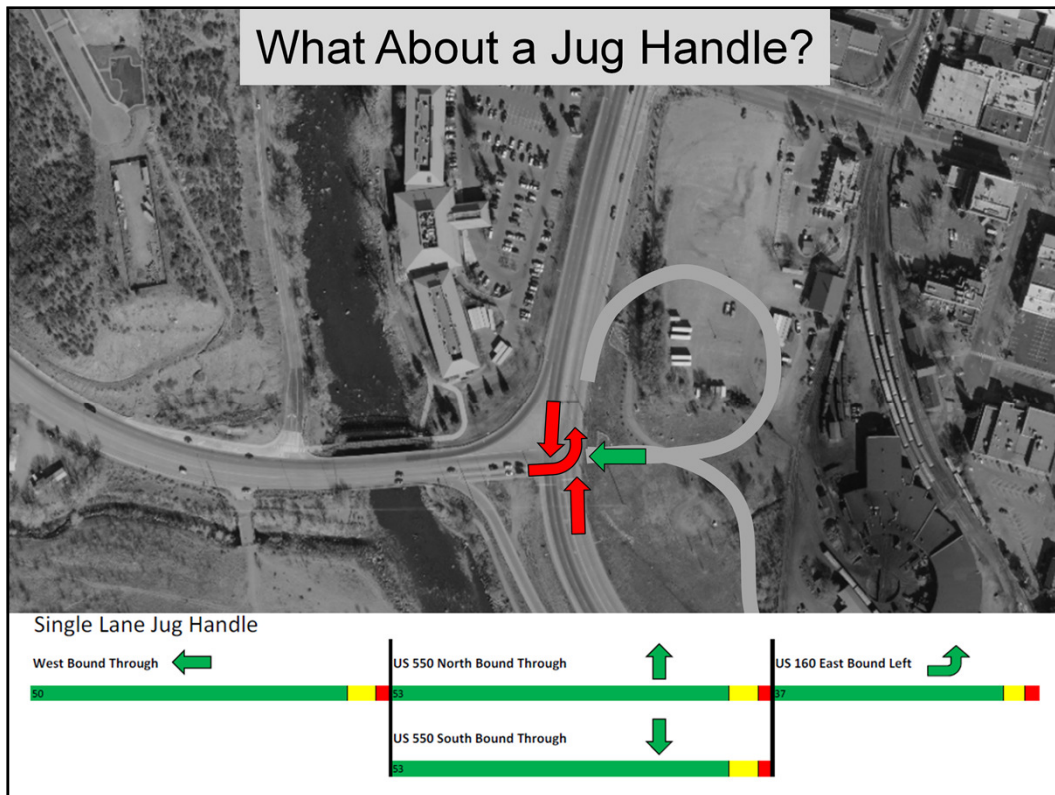
Traffic Volumes, Travel Times, Comfortable Roadside Environments, etc. are all competing desires, and often improving one can degrade others.

What About a Jug Handle?



This is an aerial photograph of a jug handle intersection. The clover leaf ramp in the top right is known as a far side jug handle, while the ramp in the bottom right is known as a near side jug handle. The concept is to remove left turns off of the major road by having them first exit right, then combine with the side street traffic, and then make a through movement from the side street. In certain cases this intersection type can improve the operational efficiency of the intersection.

(fewer signals, signal coordination, fewer disruptions to smooth flow of traffic)

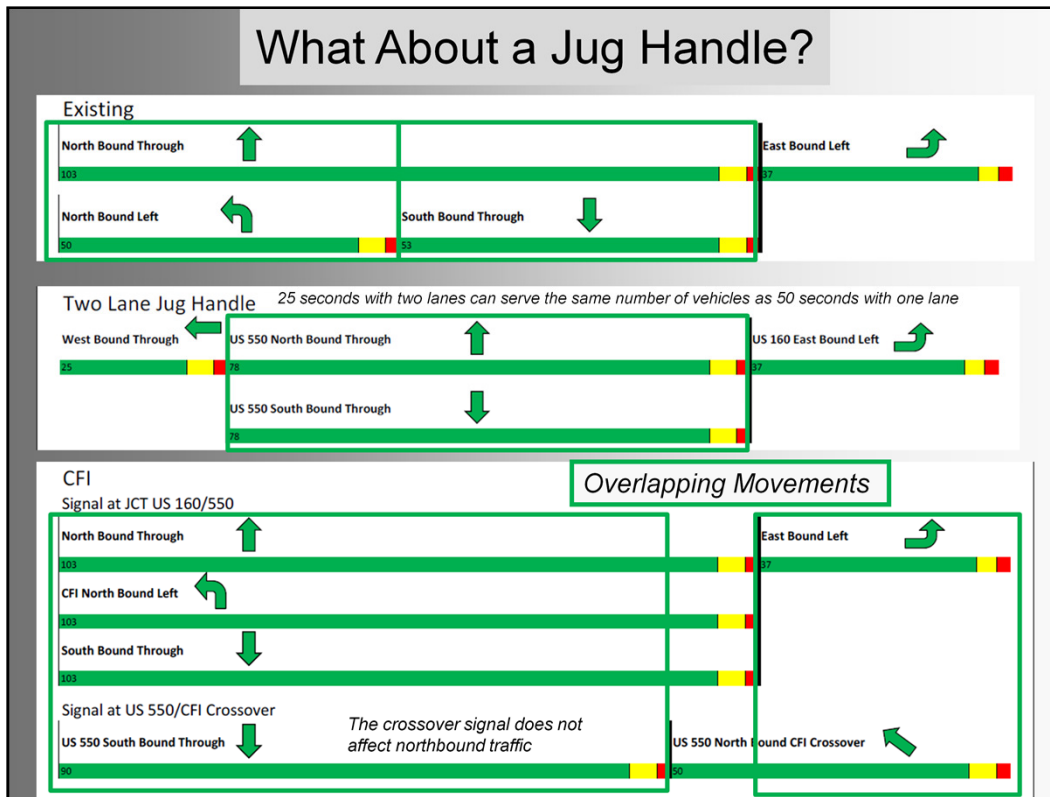


For the project location, a far side jug handle would require significant additional property (the rail road parking lot). A near side jug handle would be possible. Either jug handle simply makes the existing northbound left a westbound through. A westbound through would not only conflict with the eastbound left and southbound through movements as does a northbound left, but it would additionally conflict with the northbound through. Adding a conflict to the northbound through makes coordination of the NB through and southbound through movements much more difficult. For a single lane jug handle, using the existing timing example, if you kept eastbound left, southbound through, and westbound through (i.e. northbound left) the same, you would lose 50 seconds of green time for the northbound through. You could split the lost 50 seconds among all the movements, but the end result is that a single lane jug handle would perform worse than the current intersection.

A two lane jug handle for the westbound through, if long enough, could theoretically cut the current 50 seconds in the example in half to 25 seconds if both lanes are used by traffic evenly (See example timings on the next page). You could spread those 25 seconds among northbound, southbound and westbound, but in the end, for a lot of money, you would end up with less time for northbound and a more difficult intersection to coordinate.

In contrast, a single lane CFI performs better and is far cheaper than a two-lane jug handle (See next slide)

What About a Jug Handle?



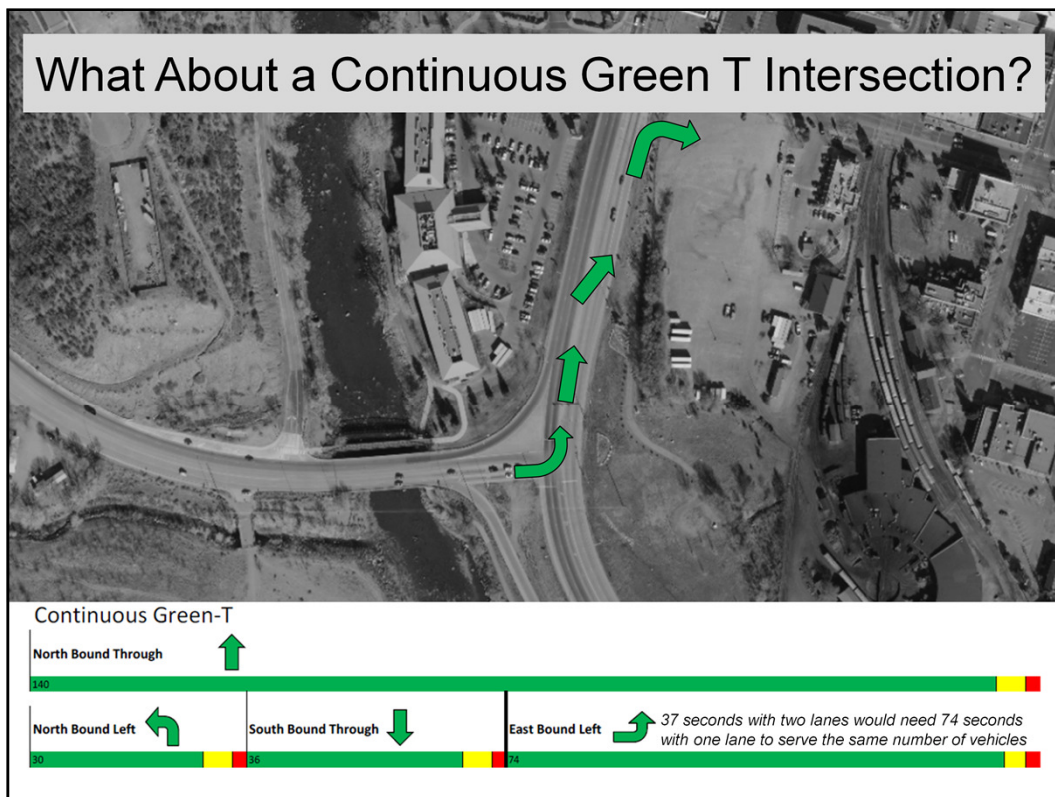
This slide shows the summer PM timing plan at the existing signal, and compares that to allocating an equivalent amount of time to a two lane jug handle or the proposed single lane CFI. To keep the example simple, the eastbound left timings and the existing 50 seconds for a single lane for the total northbound to westbound movement are kept the same. Any additional time was given to the northbound and southbound through movements. The green boxes show overlapping movements, which are movements that can occur at the same time because they do not conflict. What the example shows is that a single lane CFI has many more overlapping movements (i.e. fewer conflicting movements), which provides the opportunity to add more green time to multiple movements without negatively impacting other movements. Earlier in the slide show we showed giving more green time (i.e. more green = less red time for that movement per cycle) to the CFI crossover movement to minimize stacking in the left turn pocket. The final timings will look at volumes for all movements, how to best divide up time amongst those movements, and how to best coordinate the CFI signals with the Santa Rita and College Dr. signals with their respective timings, etc.

With intersections the more movements with significant volumes that can overlap, the better operational efficiency of that signal.

What About a Continuous Green T Intersection?



This is a photograph of the continuous green-t intersection currently at Farmington Hill. It is called a continuous green t because the westbound traffic never has to stop. The State Highway 3 intersection with US 160/550 near Walmart is also a continuous green-t.



A continuous green-t at the west junction of US 160/550 would be problematic for several reasons. First, the painted median space for the north leg of the intersection allows room for a single lane, which would require the eastbound left to be cut from two lanes to one (i.e. you can't have two lanes turning into a single lane at the same time). Second, with the volumes this segment of roadway sees, the weave from the single lane within the painted median space to the right turn lane across the two northbound through lanes that would no longer stop would be difficult at best. Third, while continuous green-t's can have safety (removing left turn and through movement conflicts) and operational benefits (through movement no longer stop) for motorized traffic, especially at high speed locations, they are counterproductive to the traffic calming measures.

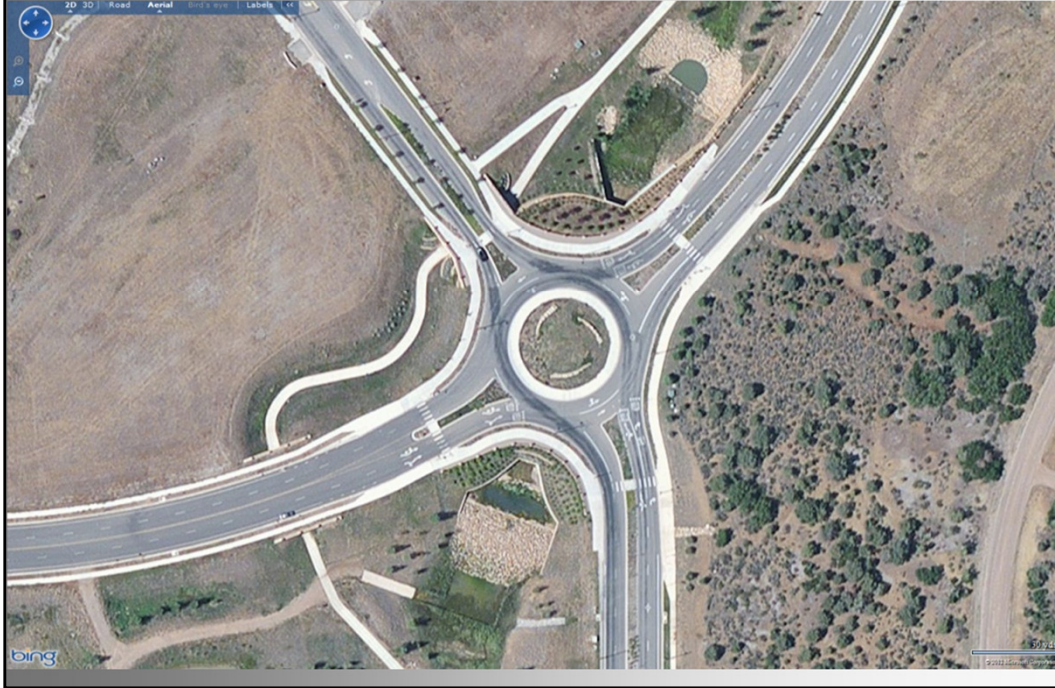
The example timings follow previous examples in allocating an equivalent amount of time to serve the movements as the existing signal. As can be seen here, the Northbound left and southbound through movements would be adversely impacted by reducing the turn lane from two to one lane. While the northbound through would receive more time, it already receives significant green time with both the existing signal and proposed CFI. Since the northbound through really is not the issue at the west US 160/550 junction, the continuous green-t has a lot of negatives with no positives at this specific location.

A continuous green-t would be cheap to install, but it would perform worse than the current existing intersection.

The northbound through is one of the several issues at College/Camino, and is just one

reason why the project is also looking at improving that intersection.

What About a Multi-Lane Roundabout?



This is a photograph of a multi lane roundabout in Three Springs.

What About a Multi-Lane Roundabout?

Results for Intersections														
#	TYPE OF INTERSECTION	Sheet	Zone 1 (North)		Zone 2 (South)		Zone 3 (East)		Zone 4 (West)		Zone 5 (Center)		Overall v/c Ratio	Ranking
			CLV	V/C	CLV	V/C	CLV	V/C	CLV	V/C	CLV	V/C		
1	Conventional	FULL									1297	0.81	0.81	7
2	Conventional Shared RT LN	CSRL									2103	1.31	1.31	14
3.1	Quadrant Roadway	S-W			1492	0.93			962	0.60	604	0.38	0.93	9
3.2		N-E	1334	0.83			518	0.32			1297	0.81	0.83	8
3.3		S-E			1281	0.80	1281	0.80			1077	0.67	0.80	6
3.4		N-W	1577	0.99					1114	0.70	1297	0.81	0.99	12
4.1	Partial Displaced Left Turn	N-S	812	0.51	1054	0.66					823	0.51	0.66	1
4.2		E-W					0	0.00	366	0.23	1273	0.80	0.80	5
5	Displaced Left Turn	FULL	812	0.51	1054	0.66	0	0.00	366	0.23	823	0.51	0.66	1
6.1	Restricted Crossing U-Turn	N-S	845	0.53	1084	0.68	812	0.51	1078	0.67			0.68	3
6.2		E-W	2857	1.79	2833	1.77	1030	0.64	1148	0.72			1.79	15
7.1	Median U-Turn	N-S	1120	0.70	1084	0.68					2076	1.30	1.30	13
7.2		E-W					535	0.33	409	0.26	1093	0.68	0.68	4
8.1	Partial Median U-Turn	N-S	1395	0.87	824	0.52					1549	0.97	0.97	10
8.2		E-W					260	0.16	409	0.26	1549	0.97	0.97	10

Existing Signal

Proposed CFI

Results for Roundabouts															
#	TYPE OF ROUNDABOUT	Zone 1 (North)			Zone 3 (East)			Zone 2 (South)			Zone 4 (West)			Overall v/c Ratio	Ranking
		Lane 1	Lane 2	Lane 3	Lane 1	Lane 2	Lane 3	Lane 1	Lane 2	Lane 3	Lane 1	Lane 2	Lane 3		
9.1	1 X 1	2.48			2.62			2.36			0.00			2.62	#DIV/0!
9.2	1 X 2	2.16			1.33	1.28		2.07			0.00	0.00		2.16	#DIV/0!
9.3	2 X 1	0.87	1.61		1.80			1.50	0.87		0.00			1.80	#DIV/0!
9.4	2 X 2	0.77	1.41		0.98	0.89		1.34	0.76		0.00	0.00		1.41	#DIV/0!
9.5	3 X 3	0.00	0.80	1.25	0.65	0.66	1.03	0.32	1.09	0.74	0.00	0.00	####	#DIV/0!	#DIV/0!

Best Roundabout

Existing Signal

Proposed CFI

Best Roundabout

During the public meeting on 12-12-12, a member of the public strongly urged that a roundabout be considered and cited a Federal Highway Administration (FHWA) document on the benefits of roundabouts. While roundabouts can be excellent tools, work well at some locations, and can outperform signalized intersections at low to moderate volumes, they are not a good solution in all situations. CDOT responded at the public meeting that roundabout options at this location were not a good solution, and stated that a planning level tool provided by FHWA (same source cited by the member of the public) was used for intersection comparison purposes. The tables shown on this slide are from the FHWA intersection planning tool discussed at the public meeting using summer 2011 PM motorized traffic counts, and adjusted by the default values in the program. v/c ratio = volume to capacity ratio. Green is good, red is the worst and means the intersection is overcapacity meaning the intersection can not handle the volume.

The roundabout options perform worse than the current intersection, and would be significantly overcapacity with current volumes, let alone future volumes. The proposed CFI performs far better than the existing signal, which in turn performs far better than roundabout options. Even if the eastbound right and southbound right turns bypassed and did not enter the roundabout (a common method for increasing roundabout capacity and possible at this location) the roundabout would still be over capacity with current volumes and perform **worse** than the current existing intersection.

A multilane roundabout would be very large at this location in order to accommodate the large trucks that rely on the state highway system and this junction. While truck aprons

(sloped curb with raised pavement towards the center of a roundabout) can be used to handle occasional larger vehicles, with multilane roundabouts, trucks will often take up more than one lane vs. using the truck apron (for a single lane roundabout trucks are essentially forced to use the truck apron). A large multi lane roundabout would be very costly since it would require a complete reconstruction of the intersection and approaches to the roundabout. Such a project would create a larger impact on the local community during its construction. The proposed CFI is an add on retrofit with far lower costs and construction impacts.

A question was asked regarding having more than two lanes within the circular portion of the roundabout. A single left turn lane turning into multiple through lanes is limited by the single left turn lane. The same is true for roundabouts, if there are fewer lanes on the approach than within the circular portion of the roundabout, then the approach is the primary limiting factor to the roundabouts capacity. A two lane approach to a more than two lane roundabout would have minimal additional capacity.

What About a Conventional 2nd Northbound Left Turn Lane?

Results for Intersections														
#	TYPE OF INTERSECTION	Sheet	Zone 1 (North)		Zone 2 (South)		Zone 3 (East)		Zone 4 (West)		Zone 5 (Center)		Overall v/c Ratio	Ranking
			CLV	V/C	CLV	V/C	CLV	V/C	CLV	V/C	CLV	V/C		
1	Conventional	FULL									1076	0.67	0.67	3
2	Conventional Shared RT LN	CSRL									2103	1.31	1.31	14
3.1	Quadrant Roadway	S-W			1492	0.93			962	0.60	604	0.38	0.93	9
3.2		N-E	1334	0.83			518	0.32			1297	0.81	0.83	8
3.3		S-E			1281	0.80	1281	0.80			1077	0.67	0.80	7
3.4		N-W	1577	0.99					1114	0.70	1297	0.81	0.99	12
4.1	Partial Displaced Left Turn	N-S	812	0.51	1054	0.66					823	0.51	0.66	1
4.2		E-W					0	0.00	366	0.23	1273	0.80	0.80	6
4.1	Partial Displaced Left Turn	N-S	812	0.51	823	0.51					845	0.53	0.53	1
4.2		E-W					0	0.00	366	0.23	1273	0.80	0.80	6

Double Northbound Left

Proposed Single Lane CFI

Double Lane CFI

Adding a second left turn lane to the existing conventional signal would require widening the highway for the south leg of the intersection for a significant distance within constrained right of way, which would be more costly than the proposed CFI. Also, for less cost, the proposed single lane CFI performs slightly better than a conventional double northbound left turn intersection as shown in the table on this slide.

The same costs for adding a second northbound left turn lane to the conventional signal would be necessary to add a second CFI lane. However, with minimal additional cost, a double lane CFI performs significantly better than a conventional double northbound left intersection. At the project location, with the same number of lanes, a CFI performs far better than a conventional intersection.

Summarizing Other Intersection Types

- What About?
 - Multilane Roundabouts
 - Jughandles
 - Continuous Green T's
 - Additional Left Turn Lanes
- *For this location a CFI works better and costs less*

What About an Interchange/Tunnel/Flyover?



This is a contemporary depiction of the interchange that was designed for the project location nearly 40 years ago and for which the property to the west of the intersection was acquired long ago. The interchange has yet to be built for many reasons as discussed on the next slide.

CFI Project Typical Questions

- What About an Interchange/Tunnel/Flyover?
 - Costly
 - Cost Benefit with close proximity to signalized intersections
 - Competition for Limited Funding
 - Public Opposition
 - Gateway Treatments Difficult
 - Interchanges Carry More Traffic, Obviously
 - Anything is possible and easy on paper/computers, in a vacuum, plans drafted for multiple Durango interchanges
 - However, designing for a transportation system with multiple competing needs, ROW constraints, limited funding, etc. is more challenging= *Actual Engineering*

Over the last 40 years the interchange project has failed to receive funding, and funding such an expensive project is not on any short or long range plans. There are various reasons why this is the case:

1. **Funding-** An interchange is incredibly costly and would cost many millions of dollars more than the proposed CFI. CDOT Region 5 covers the entire southwest quarter of Colorado, north to near Montrose, east past Alamosa, through Chafee county, and to the borders with Utah and New Mexico. Currently there are two interchanges in the entire Region, Mesa Verde and the Grandview interchange, which is obviously a work in progress. There are no interstate highways whatsoever in Region 5. Plans for other interchanges in the Durango area have been developed to varying degrees for US 160/Santa Rita (CDOT owns the majority of the land that is Santa Rita Park, and the community gathering place this park has become seems a far better use of the space than making it interchange ramps), US 160/Sawyer, US 160/SH 3 near Walmart, US 160 Three Springs, and US 160/SH 172. CDOT Region 5 receives a small fraction of the State Transportation budget compared to the larger population areas along the front range of Colorado (i.e. Denver, Colorado Springs) or areas with the interstate system. Region 5 covering such a large area of the state and having a small fraction of the budget results in more transportation needs than available funding. If additional funding becomes available, Region 5 must compete with the larger population areas of Colorado or the locations with the interstate system. Often the larger population and interstate areas win the competition because of the huge transportation demands they face or have

greater significance in the national transportation infrastructure. Because of the fierce competition, there is no such thing as a project piggy bank. There is always another project that could provide an immediate, often greater benefit than the interchange at this specific location. In addition, the aging, massive roadway transportation system across the country requires significant amounts of money to maintain, especially considering that many structures (bridges, interchanges, etc.) are nearing the end of their useful service life (Many were built in the post World War II interstate boom). The majority of Colorado's transportation budget is spent on maintaining the current system, which results in less funding for capacity expansion projects (Other states are in the same boat.)

2. **Cost Benefit-** Looking at any given location on the transportation system from a theoretical stand point is relatively simple. Look at all of your design parameters (which in an urban setting is incredibly complex), come up with a solution, and draft a set of plans. This has historically happened time and time again, often involving expensive studies. The end result, such as the list of interchange locations mentioned earlier in this e-mail, is a set of projects that are not tied to an actual funding stream, which means the projects may never come to fruition and as such are of little value. One must also look at the transportation *system* surrounding the project, is the possible orders of magnitude increase in cost of building, maintaining and eventually replacing an interchange vs. an at grade continuous flow intersection provide that much more of a benefit considering that the location is surrounded by signalized intersection choke points (Camino/College within very close proximity, US 160/Santa Rita, and if development west of the intersection comes to pass signal warrants will likely be met at the busier intersections along US 160 west)? If continued traffic growth causes the traffic trying to get through a signalized College and Camino intersection to back up and block the ramps of a west junction of US 160/550 interchange, for the huge additional cost of an interchange what have you gained?
3. **Public Opposition-** The interchange at the west junction of US 160/550 has historically been opposed by proposed adjacent business development and the local community who is worried about an interchange in the heart of Durango changing the look and character of the entrance to the City core, and pushing highway type roadway onto Camino del Rio that is for all practical purposes a City street (Closely spaced intersections and signals, heavy roadside development with numerous access points to the roadway, etc.) Gateway Treatments or other traffic calming measures are inherently difficult with an interchange that is more common of the high speed interstate highway system. The Colorado Transportation Commission is unlikely to fund a project with huge public opposition.

A full interchange at the west junction of US 160/550 has not been funded for ~40 years thus far, and in the current/projected fiercely competitive funding environment, it stands little chance vs. other projects of being funded because of its huge cost, limited available funding, poor cost/benefit, public opposition, etc.

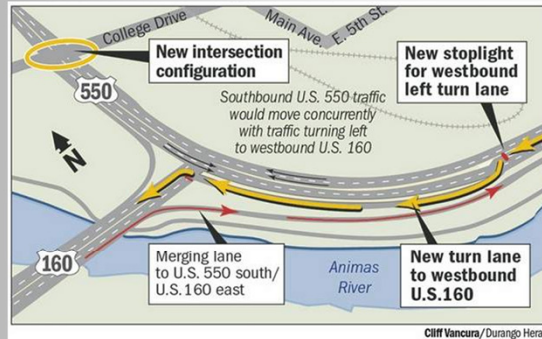
A partial interchange, such as a tunnel or flyover, has all of the same issues as a full interchange. With the added issues of:

1. Worse performance than a full interchange. A northbound left turn lane flyover or tunnel would still require a signal at the existing intersection for the eastbound left and north/south through movements. A flyover or tunnel would barely outperform a single lane CFI during the PM rush hour, and a double lane CFI would match a flyover/tunnel's performance for a fraction of the cost. For all other times of the day, the time required for the US 160 EB double left is more than what is required for the CFI single lane crossover. Since the CFI crossover and EB left occur at the same time, much of the time SB traffic would stop once for the eastbound left vs. the current condition of having to stop for the EB left and the NB left. Currently SB traffic is stopped for the eastbound left is the same time
2. Considering the proximity of the Animas River, a very long and hugely expensive bridge or tunnel would be required to flyover or under the river.
3. How would the flyover or tunnel tie in or bypass the US 160/Roosa Intersection or existing US 160 west Bridge?
4. Much of the existing concrete roadway sits atop tailings from the Uranium Smelter that used to be located where the dog park is Today, which would be a huge issue for any tunnel.
5. Drainage for a tunnel below a river would be very costly
6. Etc., etc., etc.

A tunnel or flyover would likely cost significantly more than the full interchange designed 40 years ago...

US 160/550 CFI Key Items

- Proven Across US
- Good Fit
 - Best intersection type
 - Signalized network
- Cost Benefit
 - CFI mostly in place
 - **Current** congestion will not return for 10 years
 - 10 years from now far better off with CFI and other improvements than without, CFI likely not the Durango weak link
 - Include other improvements, consolidate projects
- Limited Funding
 - Spread the available funding



While CFI's are a newer intersection type, this is no where near the first time a CFI has been proposed or constructed. There are numerous examples of very successful CFI's across the US. Utah has multiple successful CFI's, some of which have now been installed for several years. These CFI's have shown excellent reductions in congestion and accidents. Loveland, CO has a CFI intersection they are very happy with, and the City of Colorado Springs has a CFI project in the design stages.

The CFI outperforms all other at-grade intersection types for the proposed location given the number of lanes on the approaches. The CFI also meshes well within the current coordinated signalized intersection network surrounding it.

The majority of the CFI is already in place with the existing infrastructure that still has years of useful service life remaining. This makes the add on retrofit of a CFI for this intersection extremely cost effective and is a fraction of the cost of any grade separated interchange proposal.

Looking at how traffic has grown over the years, and how it is projected to grow in the future, 10 years for traffic congestion to return to current levels is a significant benefit. In ten years the project area will be far better off with the CFI and other improvements (i.e Camino/College intersection and raised median improvements). Also, in 10 years the CFI will likely not be the weak link in the Durango transportation system, meaning other

locations will be in greater need of available limited funding. It is unlikely that more costly options with poorer cost benefit ratios, such as the interchange, will receive funding 10 years from now. The proposed Continuous Flow Intersection (CFI) provides a significant improvement over the current intersection in the near and longer term.

The relatively small cost of the CFI opened up the opportunities to spread the limited available funding to also pursue the College and Camino, raised median, gateway treatments, pedestrian, bicycle, and other associated improvements. The project also consolidates multiple projects into one, which is more cost effective and creates less of a construction impact on the local community than multiple projects spread out over the years.

All of these reasons make the CFI project a good long term improvement project with excellent immediate benefits, and is why the total CFI project discussed in this presentation has received ~3 million dollars in funding. This project beat out other proposed projects within Region 5 and within the larger metropolitan areas of Colorado.

Based on numerous meetings, presentations, e-mail exchanges, one on one discussions, and other outreach efforts, CDOT feels that the majority of the public supports this project. While available funding may not allow for every single desired improvement (it is far too early in the design to determine final project estimates), and some hard decisions may have to be made to cut the project back, CDOT in partnership with the City of Durango will make every effort possible to deliver the project discussed in this presentation.

If you still have questions, I would be happy to discuss them with you further. Please feel free to contact me at Thomas.Humphrey@state.so.us.

US 160/US 550 (Doubletree) Intersection Improvements



Responses to questions and comments presented at the public meeting, separate meetings, contained within Durango Herald blogs, via e-mail, etc. are addressed throughout the notes contained within this presentation.

Next Steps


- Analyze public comments
- City Council Presentation ACP Amendment
January 2nd, 2013 6:30 - 9:00 PM
- Design

Public comments will continue to be analyzed throughout the design of the project.


The Durango City Council voted to approve option 2 regarding the Access Control Plan Amendment (See previous slides).

The project is now in the design phase.

Thank You!

- 
- Businesses and Organizations
 - Cooper Stowers
 - City of Durango
 - Durango Fire and Rescue

Thanks for Attending!

- 
- An aerial photograph of a city street, likely in Durango, Colorado. The street is shown with a rainbow-colored median line. The surrounding area includes residential buildings, parking lots, and a river or stream. The image is used as a background for the text.
- Comment forms available on table. Please let the Project Team know your comments, suggestions, or concerns.

Two written comments were received at the conclusion of the 12-12-12 Public Meeting:

1. "Looks like a good plan. Median work should continue north of 8th." In case anyone is wondering, this comment was not made by CDOT or City of Durango staff.
2. Project needs to do more to address on-street bicycle accommodations.